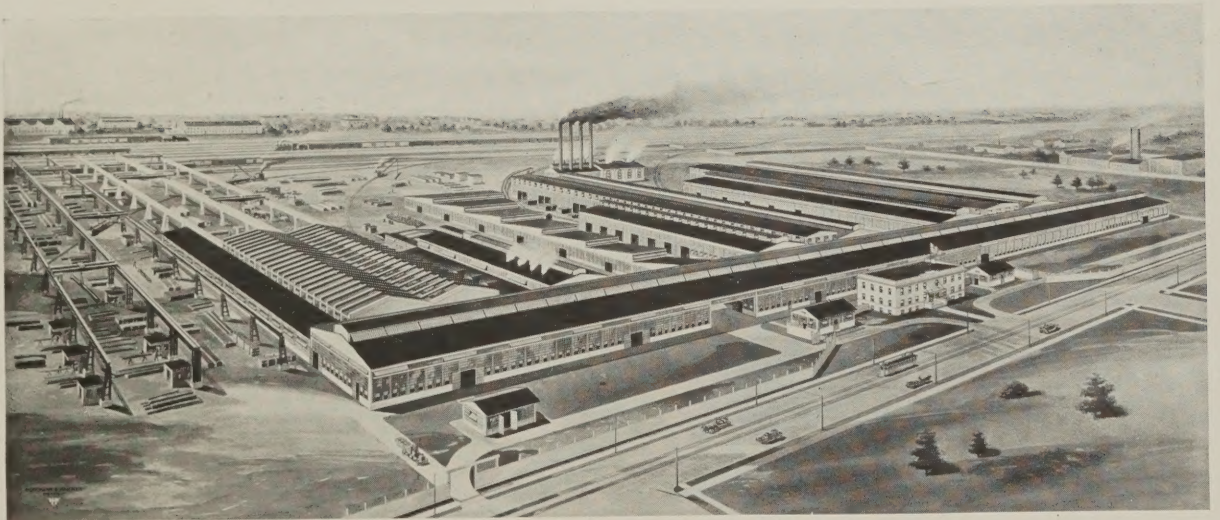
24

KAHN SYSTEM STANDARDS

Trussed Concrete Steel Co.



Main Plant of Trussed Concrete Steel Co., at Youngstown, Ohio, for Manufacture of Reinforcing Steel, Hy-Rib, Rib-Lath, United Steel Sash and other Steel Products.

Chemical Products Plant (The Trus-Con Laboratories) at Detroit, Mich.
Warehouses and Tile Plants in various cities.

Kahn System Standards

A Hand Book on Reinforced Concrete

KAHN
Building
Products
TRUSSED
CONCRETE
STEEL
CO

Fifth Edition
Revised and Enlarged
1913

H. Saur.

GENERAL SALES OFFICES OF
TRUSSED CONCRETE STEEL CO.
Moved to Plant at
YOUNGSTOWN, OHIO

No. ______________

To ____

Limited Edition for Special Distribution

Fifth Edition
1913

Price $ .50

Reinforced Concrete

How First Used

WHEN, in the late 60s, Monier, a French gardener, began making flower pots, boxes and small water tanks out of concrete and imbedded wire in the material to increase its strength and decrease its weight and bulk, he little thought that forty years later the principle he employed would be used throughout the entire world in the erection of millions upon millions of dollar's worth of construction work. There has been no class of structures, no line of the building trades which has not been affected by reinforced concrete, and many of them have been revolutionized. The story of the development and growth of the use of this form of construction has filled volumes, while here it can only be touched upon briefly.

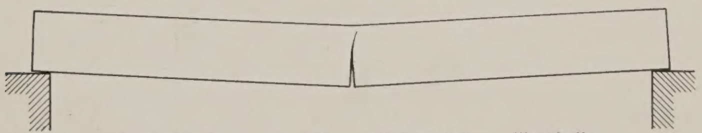
Concrete Defined

Concrete is a rock-like substance formed by the mixture of cement, sand, stone and water. It is the result of the cementing together, through chemical action between the cement and water, of various sizes of stone so proportioned with the other material that all voids within the resulting mass are filled.

Reinforced Concrete Defined

Reinforced concrete is exactly what the name implies. It is concrete in which steel has been imbedded to give additional strength and elasticity.

Plain concrete, when used in the form of pillars and posts, is capable of carrying heavy direct loads through its great compressive strength. But when it is subjected to a direct pull, that is, to tensile strains, it is weak. For example, if a



No reinforcement. Small load—Sudden failure—like chalk.

plain concrete beam is subjected to a load it will break apart at the bottom just as a piece of chalk would under like conditions, being unable to resist the tension in the lower portion of the beam. In order to overcome this, reinforcing steel is used to give proper tensile strength and elasticity. The concrete in the top of the beam takes care of the com-

pression. A properly reinforced concrete beam has, therefore, the strength of stone in resisting compression, united with the tension resisting power of steel.

When a beam is loaded and supported at the two ends, it will have a tendency to deflect. To illustrate, assume that a beam is made up of a series of flat plates, or, in other words, like a pad of paper or a book, the difference being that in the pad of paper the leaves are not in any way connected to each other, whereas in a beam the adhesion of the various particles of the material ties the imaginary plates together. Now, when the supposed beam starts to deflect, one of two things will happen. Either the various plates separate, as when a book or pad of paper is bent, and in separating slide by one another; or, if the plates are held together and sliding is prevented, the particles in the upper plates compress and in the lower plates elongate.

It is thus seen that in addition to the compression and tensile stresses in the top and bottom of the beam, there are internal stresses of equal importance against which the concrete must also be properly reinforced. To accomplish this it will be absolutely necessary that there should be diagonal steel reinforcement extending well up into the mass of the concrete. This latter reinforcement *must be rigidly connected to the steel in the bottom of the beam* in order that all the steel may act together with the concrete in forming a properly reinforced beam. The Kahn Trussed Bar with its rigidly connected diagonals is, therefore, the ideal reinforcement.

Kahn Trussed Bar Described

The Kahn Trussed Bar is made of a special grade of medium open-hearth steel with an elastic limit up to 42,000 pounds and an ultimate tensile strength of 70,000 pounds per square inch. The cross section (see pages 15 to 17), has two horizontal flanges or wings, projecting at opposite sides. These flanges are sheared up at intervals to form the rigidly connected diagonals, making a unit of main bar and shear members.

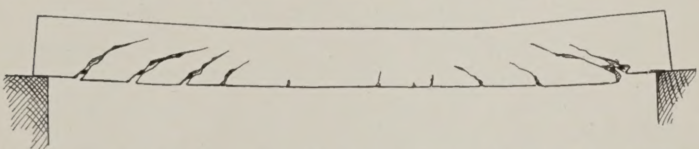
Kahn Trussed Bar—with alternating diagonals.
Note rigidly connected shear members.

General History of the Methods of Reinforcing Concrete

A BRIEF review of the general types of reinforcement used in the past, will make clear why they have been either abandoned or revised, and why the Kahn Trussed Bar is now considered the *perfect reinforcement*, incorporating all the advantages of the old forms with the more modern improvements and refinements.

Horizontal Only

It was originally thought that merely imbedding steel bars in the bottom of a concrete beam to take the tension was sufficient. This is true in some rare instances. While enough steel may be placed in the bottom of a beam, which, if pulled in a testing machine, could resist the desired amount



Horizontal reinforcement only. Method of failure when tested to destruction. Light load. Sudden failure caused by ends of reinforcement slipping and horizontal shear diagonal cracks in concrete.

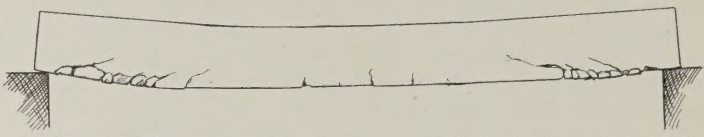
of tension, it must be remembered that it is necessary to get the stress into the steel from the concrete, and there must be some positive means of doing this. The old idea was to depend upon adhesion. This was soon found to be inadequate and unreliable, as the plain bars would slip.

In order to overcome this difficulty deformed bars of various types, such as twisted bars and bars with corrugations and lugs, were used to increase the friction between the steel and the concrete. When such bars were laid in the bottom of a concrete beam they did not slip in the concrete but the concrete would shear along a plane immediately above the bar. For this reason the strength of the bar could not be developed, and the beam was practically no stronger than if reinforced with plain bars.

Loose Stirrup

Numerous tests were made on the older form of horizontal reinforcement and it was universally observed that when a beam was tested to destruction, it failed by the breaking of the concrete along lines beginning at the reinforcement at

the ends and extending diagonally upwards towards the center of the beam. The cause was not known, but it was assumed that there were stresses in the concrete, and therefore loose vertical stirrups were placed in the mass of the

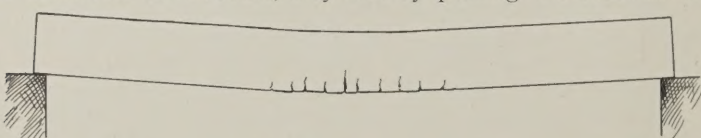


Horizontal reinforcement and loose stirrups. Method of failure when tested to destruction. Medium load. Sudden failure due to slipping of horizontal rods. Shear of concrete on horizontal plane above bars but no diagonal cracks.

beam to resist these stresses. When beams were tested to destruction it was found that the main bar slipped and that the beam failed by shearing along a horizontal plane connecting the steel with the concrete.

Rigidly Connected Web Members

It was thus demonstrated that a positive connection must be made between the main steel bar and the members taking the web stresses. This led to the invention of the Kahn Trussed Bar. In this patented bar the members in the vertical plane, being made from a part of the main tension member, transmit stress from the body of the beam directly to the main steel bar. This is the ideal reinforcement. When beams, which have been reinforced with the Kahn Trussed Bar, are tested to destruction, they fail by pulling the steel in two



Kahn reinforcement. Method of failure when tested to destruction. Maximum load. Very gradual and ideal failure. Steel stretching in center.

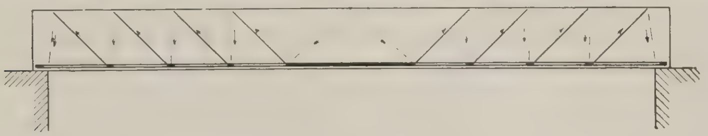
at the center, showing that there is absolutely no unknown weakness in the beam and that the full proportion of the strength of all the materials is developed. It is, therefore, the only means of reinforcing concrete that makes it possible to obtain the full value of the materials used.

Tests made by the French Government, report of which was published in "Concrete and Constructional Engineering" of London, show that beams reinforced with Kahn Trussed Bars carry 21 per cent more load than beams reinforced with horizontal rods and loose stirrups. The area of reinforcement was the same in both cases.

Tests made at the University of Wisconsin, Madison, Wis., show that beams with Kahn Trussed Bars carry over 33 per cent more load. Complete reports of these tests is found in Bulletin No. 197 of the University of Wisconsin. (University of Wisconsin Test Report will be gladly supplied by Trussed Concrete Steel Co.)

Internal Stress Action

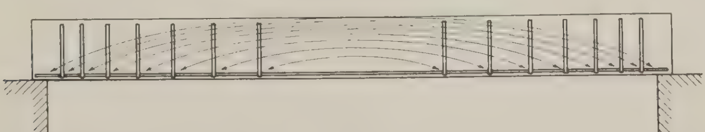
Note from the accompanying diagrams how, when a beam reinforced with the Kahn Trussed Bar is loaded, the stresses



Truss action in beam reinforced with Kahn Trussed Bars. Note the action is that of a complete Pratt truss. No tendency to slip or slide.

Truss action in beam with horizontal reinforcement and stirrups. Note the unbalanced horizontal component of the inclined stress and the tendency of the stirrups to slip along the horizontal reinforcement.

Arch action in beam reinforced with Kahn Trussed Bars. Note the perfect abutment for the inclined stresses. Perfectly rigid and no possibility of slipping.



Arch action in beam with horizontal reinforcement and stirrups. Note the unbalanced horizontal stress. Stirrups slip along the horizontal reinforcement, which, therefore, cannot be developed.

Beam with horizontal reinforcement only. Note arch action. Reinforcement furnishes no abutment for the inclined stresses, and will slip.

in the beam are resisted either by an arch or a truss. In the arch each individual stress is resisted by a positive abutment in the form of a diagonal. In the truss the steel diagonals form the tension web members and the compression web members are supplied by the concrete. The advantageous feature in this is that the tension in the diagonals is brought into the main tension member directly because tension member and diagonals are one. The thrust of the arch or the pull of the web member of the truss is resisted by the diagonal and main bar combined. It is just as essential to have rigid attachment of the diagonal members in a concrete beam as it is to have strong, close fitting rivets between the lower chord and web plate of a steel plate girder.

Certainty of Calculation

That the calculated strength of a beam may be developed it is necessary that the materials be distributed in such a manner that the ultimate strength of each would be attained should the beam be tested to destruction. This anticipates the prevention of slipping of the reinforcing bars and the failure by diagonal tension in the concrete. The Kahn Trussed Bar cannot slip and the concrete is reinforced against tension by the rigidly connected diagonals. It is clear, then, that beams reinforced with this bar will develop the ultimate strength of the materials, and, since these values are known, the materials can be so proportioned that each will be fully developed. In other words, the designer avoids the uncertainty of calculation caused by the sudden development of unexpected weaknesses. Absolute safety of design is assured.

Fireproofness

It is a well-known fact that concrete, when subjected to intense heat, of 1500 degrees Fahrenheit or over, for a continuous period, will lose a part of its water of crystallization. This condition will obtain for about one inch from the surface of the concrete in case of an extreme fire. Suppose the reinforcement is placed about one inch from the bottom of the beam. In case of a very extreme fire, the lower inch of concrete will be practically ruined and its adhesion or immediate connection with a plain bar in the bottom of the beam will be completely destroyed. With the Kahn Trussed Bar, the diagonals extend well up into the concrete beam and the effect of fire can be neglected, as the connection between the bar and its diagonals is still intact. (See Capt. Sewell's Report in Transactions of the Am. Soc. C. E.) This is perhaps one

of the greatest features of the Kahn System of Reinforcement. A building erected on this plan is as good after a fire as before, while a building reinforced with plain bars is apt to be a complete ruin.

Shock-Proofness

Actual tests show that the adhesion between the concrete and the steel is greatly weakened by repeated loading and unloading of the concrete beam. (See "Fatigue of Concrete" by I. D. VanOrnum, M. Am. Soc. C. E., Proceedings Am. Soc. C. E. December, 1906.) This means that in any structure subject to shock or moving loads, as in factories and bridges, it is not safe to rely on the bond of the concrete. Rigid connection of shear members to main reinforcement must be provided as in the Kahn Trussed Bar. The explosion at the Prest-O-Lite Company Factory, Indianapolis, Ind., is an example of how thoroughly Kahn Trussed Bars meet these requirements.

Workmanship

It is difficult in practical work to be sure that the concrete is so placed that all the steel is thoroughly imbedded, especially so in the bottom of beams. If for any reason the steel is so exposed, there can be no adhesion of the concrete and the strength of the beam reinforced with horizontal bars and loose stirrups is lost. With Kahn Trussed Bars this adhesion is not necessary. Beams have actually been built where the bars have been completely exposed on the underside and when tested to destruction developed the full strength of reinforcement.

Accuracy of Installation

The Kahn Trussed Bar reaches the job sheared and ready to be placed. The shear members are rigidly attached and cannot be dislocated either by careless labor or the pouring of the concrete. Each reinforcement is just where it belongs assuring greatest possible strength and efficiency.

Economy of the Kahn Trussed Bar

The Kahn Trussed Bar with its rigidly connected diagonals is designed to resist every stress in the concrete except that of direct compression. There is no waste metal at any point and proper reinforcement is provided at every place it is needed. In the central portion of the beam, where full area of metal is needed for resisting bending moment and

no shear reinforcement required, the bar is unsheared and the full area of the metal is available. At the ends of the beam, where the shear is a maximum and bending moment a minimum, the flanges of the Kahn Trussed Bar are struck up to form rigidly connected shear members. The shear members are thus made out of a part of the horizontal reinforcement and do not take extra steel, as in the case where loose stirrups and horizontal bars are used.

Economy of Installation

The Kahn Trussed Bar in reality consists of what may be considered as a large number of separate members, all rigidly connected and handled as a unit. All the field labor of attaching together many separate pieces is thus done away with. The practical builder well knows the great saving in handling a single piece compared with many separate individual parts.

Other Kahn Building Products

In the preceding pages were shown the advantages of Kahn Trussed Bars as reinforcement for beams, girders, joists, arches, etc. No one type of reinforcement, however, can be economically used in all classes of concrete work. Our many years of experience and the constant research of our engineers have enabled us to develop a complete series of products to efficiently meet every possible condition of practice.

Among the Kahn Building Products are included: Rib Metal, Built-up Column Hooping, Rib Bars, Hy-Rib, Rib Lath, Rib Studs, United Steel Sash, Trus-Con Chemical Products for waterproofing and finishing, Trus-Con Inserts, Trus-Con Curb Bars, Trus-Con Expansion Joints, Hollow Tile, Joist Hangers, Post Caps, Centering Clamps, etc. They are briefly described on pages 14 to 35, and more completely in special catalogs devoted to each product.

Kahn System Service

Kahn System represents something considerably more than the mere sale of these various products; it means an experience in over fifteen thousand important structures of all kinds in all parts of the world. It means an Engineering Department organized to give you the full benefit of this experience in the planning and construction of your building work. It means that you are dealing with a $2,000,000 organization of recognized reputation and responsibility, which can afford to

deliver only one class of service and that the best; an organization which you can be sure will only supply the very best materials, and designs which are reliable but not extravagant.

The design of a modern reinforced concrete structure requires scientific study in order to combine the various materials in the most economical and efficient manner. The conscientious designer must consider the purpose for which the structure is built, the arrangement of columns, beams and slabs, and the relative economy of different materials in various localities.

Engineering Department, Trussed Concrete Steel Co.

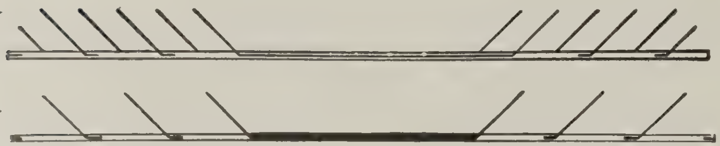
It is to take care of all such matters as these, to study each particular problem from every possible angle in order to get the best possible construction for each individual structure, that the Trussed Concrete Steel Co. has organized its large Engineering Department, with branches in all principal cities. In this Department are men of technical training and of wide experience in the engineering field, who are familiar with every type of construction and have specialized in reinforced concrete. This experience in reinforced concrete in all its applications places this department in a position to give expert advice on all such work. This advice, together with valuable suggestions is given without cost to all parties contemplating building. We especially invite Architects, Engineers and Builders to avail themselves of this service in connection with any work they have in contemplation.

Complete Designs of Reinforced Concrete Work

For any work in which it is decided that the Kahn System will be used, complete detailed drawings and designs of the reinforced concrete construction are prepared. These drawings show clearly the exact location of each reinforcing bar and the detailed size of all the concrete work. Each bar, when it leaves the factory, is given a distinctive mark which corresponds with its marking on the drawing. Each bar is designed for a distinct place in the structure, and the builder can tell at a glance where it belongs. The plans are prepared without cost for any structure in which the Kahn System is used. We co-operate to the fullest extent with all Architects, Engineers and Contractors.

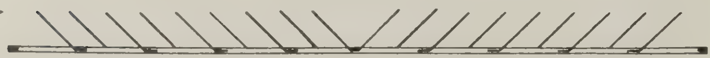
Shearing of Kahn Trussed Bars

† *



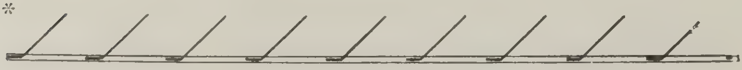
Standard Shear of Kahn Trussed Bar.
Middle Portion Left Unsheared.

†



Center Shear of Kahn Trussed Bar.
Entire Bar Sheared to Center.

*



One Way Shear of Kahn Trussed Bar.
All Diagonals Sheared Inclining in one direction.

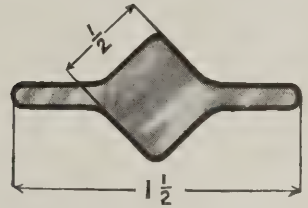
†

Special Shearing of Kahn Trussed Bar.
As directed by purchaser.

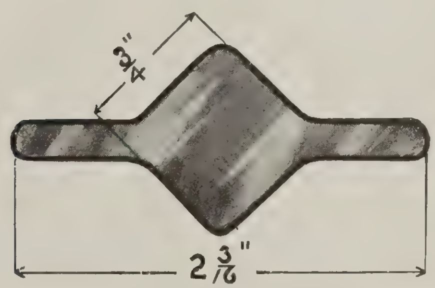
NOTE:—Sketches marked (†) shows shearing of bars with diagonals alternating as provided on 8-inch, 12-inch, 18-inch, 24-inch, 30-inch, 36-inch and 48-inch diagonals.

Sketches marked (*) shows shearing of bars with diagonals opposite as provided on 6-inch diagonals only.

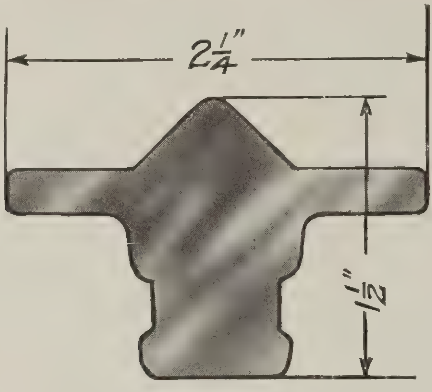
Sections of Kahn Trussed Bar



½″x1½″ Kahn Trussed Bar.
Weight—1.4 pounds per foot.
Area—0.41 square inches.
Standard length of diagonals—12 inches.
Special lengths—6 inches and 8 inches.



¾″x2$\frac{3}{16}$″ Kahn Trussed Bar.
Weight—2.7 pounds per foot.
Area—0.79 square inches.
Standard lengths of Diagonals—12 inches, 24 inches and 36 inches.
Special lengths—8 inches, 18 inches and 30 inches.



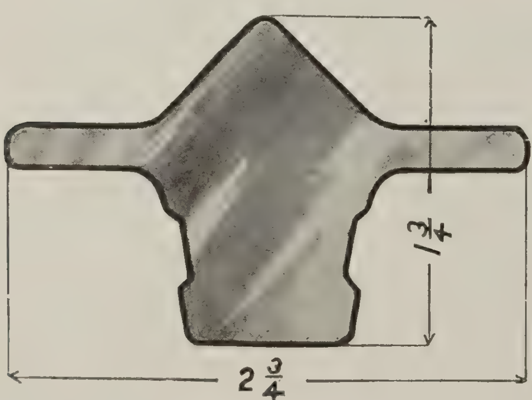
1½"x2¼" Kahn Trussed Bar.

Weight—4.8 pounds per foot.

Area—1.41 square inches.

Standard lengths of Diagonals—12 inches, 24 inches and 36 inches.

Special lengths—18 inches and 30 inches.



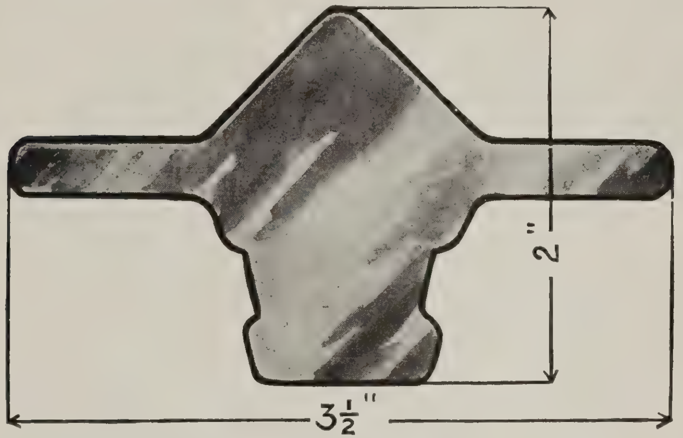
1¾"x2¾" Kahn Trussed Bar.

Weight—6.8 pounds per foot.

Area—2.00 square inches.

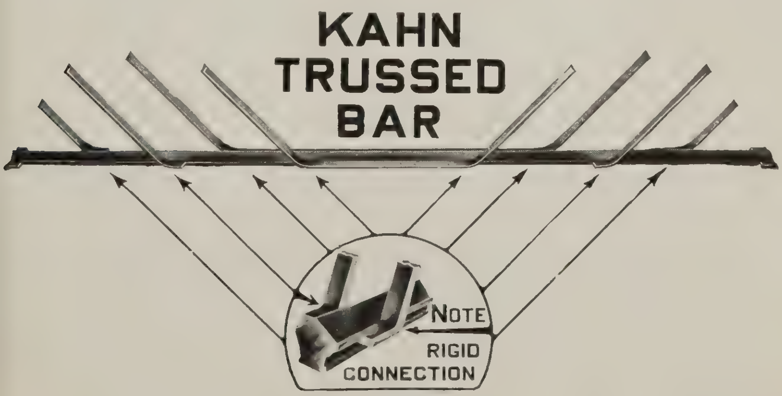
Standard length of Diagonals—36 inches.

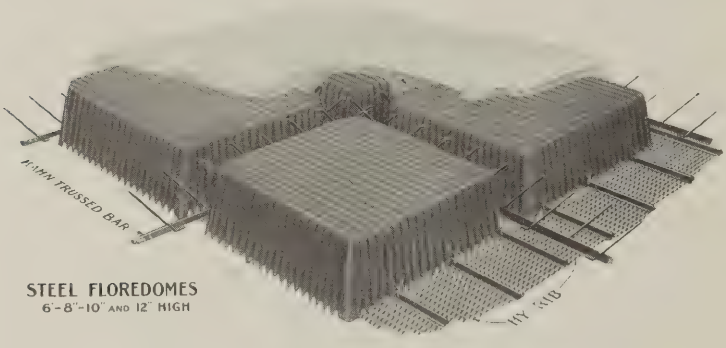
Special lengths—18 inches, 24 inches, 30 inches and 48 inches.



2″x3½″ Kahn Trussed Bar.
Weight—10.2 pounds per foot.
Area—3.00 square inches.
Standard length of Diagonals—36 inches.
Special lengths—24 inches, 30 inches and 48 inches.

Kahn Trussed Bars are manufactured from the highest grade of open-hearth steel and are shipped cut to exact length ordered. Bars up to 60 ft. in length are carried in stock at Youngstown, Ohio. Any desired length of diagonal or type of shearing can be furnished.





Steel Floredomes

Floredomes are rectangular dome-shaped steel tiles open on the under side. The deep corrugations on all sides give exceptional stiffness to the Floredomes, so as to support the trucking loads coming on them during construction. Reinforced concrete joists extend on all four sides of the Floredomes carrying the loads in two directions to the supports. A flat ceiling is obtained by the use of Hy-Rib which extends continuously underneath and produces an ideal surface for plaster. The serrated bottom edges of the Floredomes straddle the ribs of the Hy-Rib and engage in the Hy-Rib mesh. Wires attached to these ribs extend into the joists.

Steel Floredomes have many advantages over the terra-cotta hollow tile, being absolutely water-tight; light in weight; free from loss due to breakage; subject to greatly reduced freight rates; can be shipped anywhere; save in field labor; increase speed of construction; maximum economy of concrete and steel.

Properties of Steel Floredomes:

Depth—6 in., 8 in., 10 in., or 12 in.

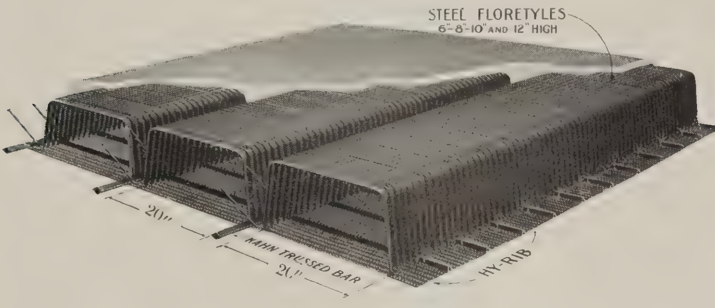
Size at Base—$21\frac{1}{2}$x$21\frac{1}{2}$ ins.

Furnished with serrated edges or straight edges.

See page 100 for Table of Safe Live Loads for Floredome Construction.

See page 83 for Illustrations of Floredome Construction.

Floredome Literature sent on request.



Steel Floretyles

Steel Floretyles are deeply corrugated steel tiles open on the under side. The bends at the corners and the deep ribs on the top provide exceptional stiffness against deformation and great rigidity in supporting loads. The narrow reinforced concrete joists between the Floretyles carry the loads to the supports. Ends of Floretyles lap with a tight joint. Floretyle Construction effects a great saving in concrete, steel, centering and weight.

For flat ceilings, Hy-Rib is used on the underside. The bottom edges of the Floretyles are serrated to straddle the ribs of the Hy-Rib and engage in the mesh. Floretyles are used with one-way reinforcement and Floredomes with two-way reinforcement. Both possess the same marked advantages over terra cotta tile.

Properties of Steel Floretyles

Depths: 6 in., 8 in., 10 in., and 12 in.

Width at Base: 20 inches.

Standard Lengths (nominal), 4 feet and 3 feet. Actual lengths are one inch greater, to allow for end lap.

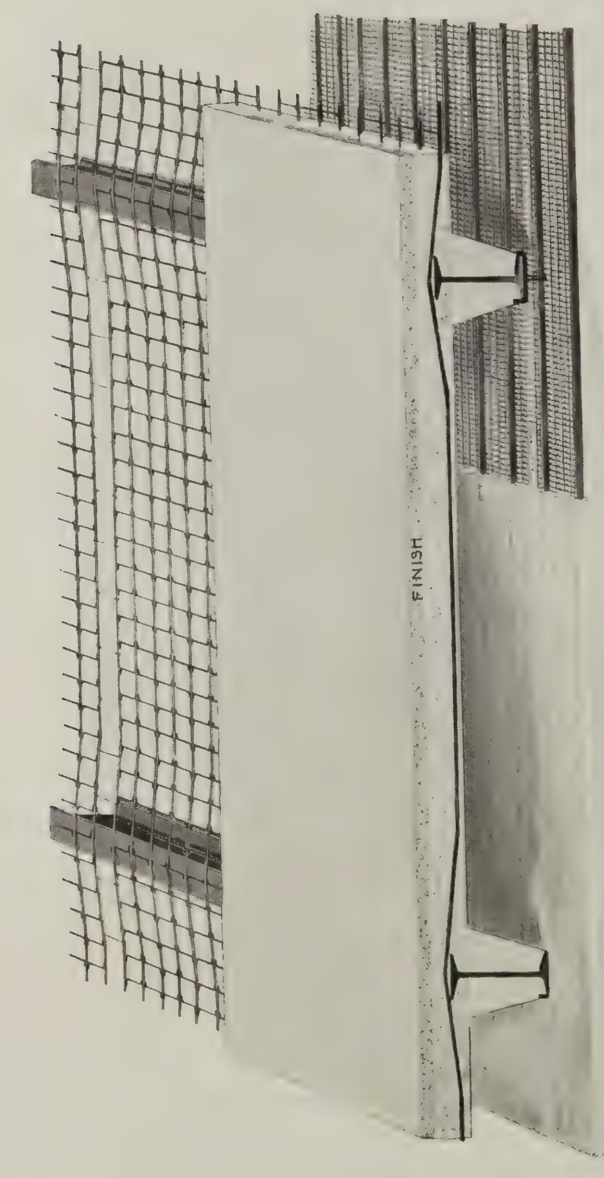
End Floretyles close the rows of Floretyles and are 2 feet (nominal) in length, actual length being 1 inch greater to allow for lap.

Furnished either with serrated edges or straight edges.

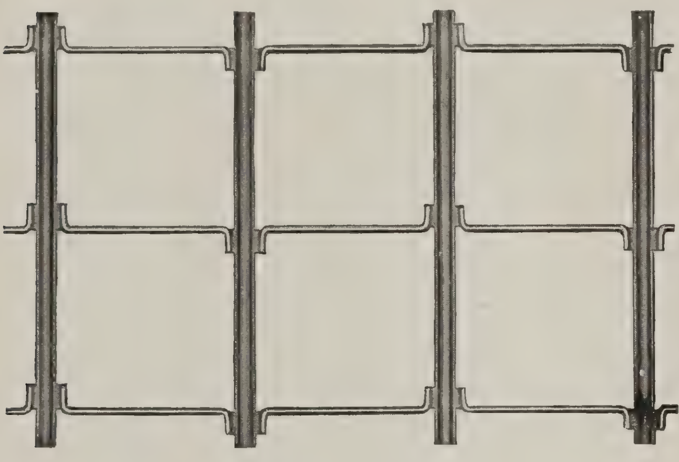
See page 101 for Table of Safe Live Loads for Floretyle Construction.

See pages 84 and 85 for Illustrations of Floretyle Construction.

Floretyle Literature sent on request.



Concrete Floor Slab Reinforced with Rib Metal
Note Hy-Rib Ceiling



Rib Metal

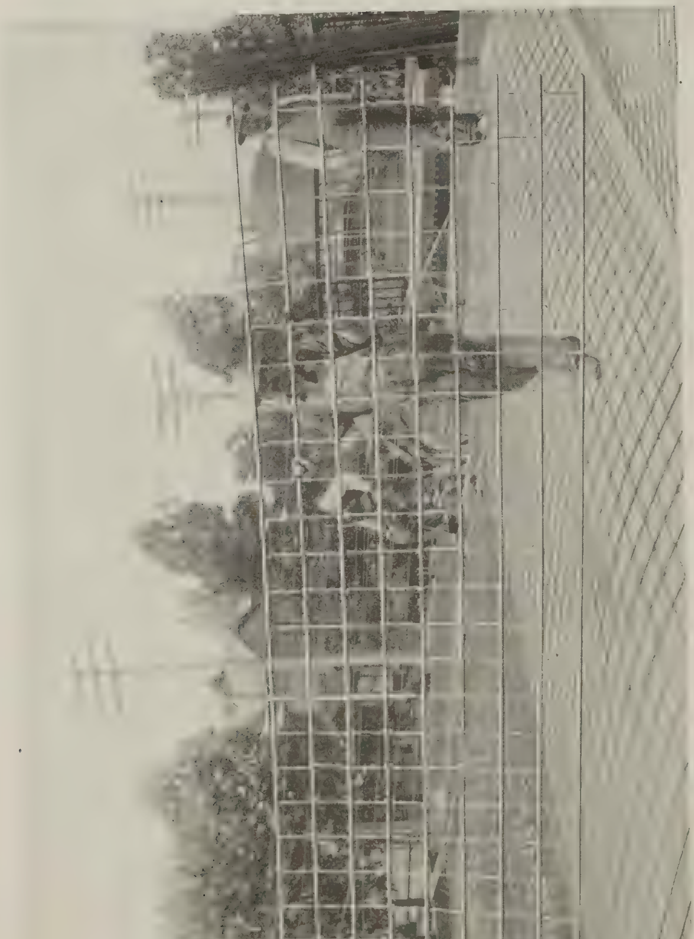
Rib Metal consists of a series of straight ribs or main tension members, rigidly connected by light cross ties formed from the same sheet of steel.

All the tension in the concrete slab is resisted by the ribs in a straight line action to the supports. The cross ties accurately space and thoroughly anchor the main ribs in the concrete, providing a perfect cross reinforcement against temperature and shrinkage strains.

Rib Metal is essentially a bar reinforcement, consisting of nine separate bars handled as one piece. Workmen can lay 100 square feet of reinforcement in the same time as would ordinarily be required to place a single bar. In this way Rib Metal saves expensive field labor, besides increasing the rapidity of construction.

The ribs are accurately spaced by the cross ties, and each rib is exactly where it belongs. There is no chance of displacing the bars by the pouring of the concrete or by careless workmen. Rib Metal is readily placed and stays in place.

The ribs span in a straight line between the supports, supplying the reinforcement in the direct line of greatest strain. Any reinforcement in the form of a diamond or triangular mesh carries the load in a long, diagonal line to the supports, and is consequently less efficient.



100 Square Feet of Reinforcement Handled as One Bar

RIB METAL Floors for the L. A. Creamery Co. Factory, Los Angeles, Cal.

F. L. Spaulding, Contractor

Rib Metal is stiff and rigid, not pliable and wirey. It reaches the job ready to be placed in the concrete. There is no field labor required to unroll and straighten coils into flat sheets.

The ribs being in a direct line with the strain do not tend to assume other positions when the slab is loaded. There is no straightening out of kinks and resultant deflection in the slab.

Rib Metal is furnished in flat sheets as reinforcement for floor and roof slabs, walls, vaults, etc.

Rib Metal is also supplied by our shops bent to exact curve as reinforcement for arches, conduits, sewers, reservoirs, tanks, etc. The shop-bending assures absolute accuracy of curve and does away with expensive field labor.

Rib Metal is made from the highest grade open-hearth steel and in seven sizes of mesh.

Properties of Rib Metal

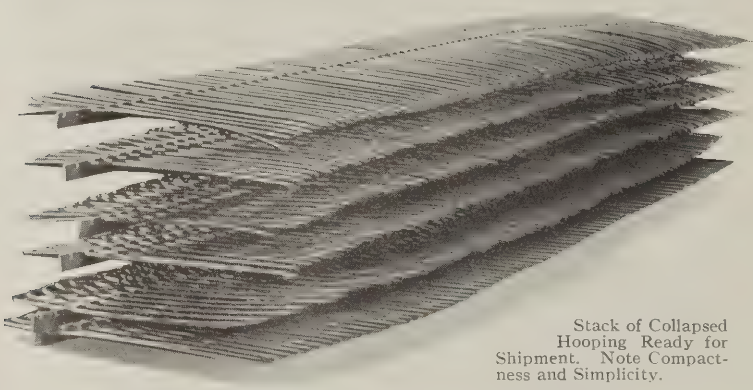
Area of one Rib=.09 sq. in. (9 Ribs in one sheet)

Size No.	Width of Standard Sheet	Square Feet per Lineal Foot	Area per Foot of Width	Weight per Square Foot
2	16 in.	1.33	.54 sq. in.	2.025 lbs.
3	24 in.	2.00	.36 sq. in.	1.340 lbs.
4	32 in.	2.67	.27 sq. in.	.997 lbs.
5	40 in.	3.33	.216 sq. in.	.792 lbs.
6	48 in.	4.00	.18 sq. in.	.655 lbs.
7	56 in.	4.67	.154 sq. in.	.557 lbs.
8	64 in.	5.33	.135 sq. in.	.484 lbs.

All lengths up to 18 feet.

Furnished in flat or curved sheets.

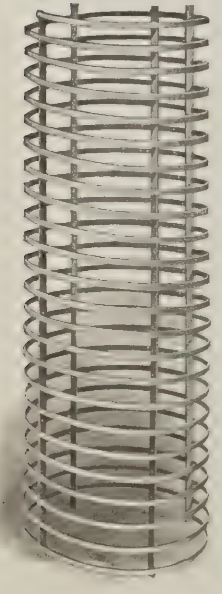
See page 97 for carrying capacities of Rib Metal Slabs.



Stack of Collapsed Hooping Ready for Shipment. Note Compactness and Simplicity.

Collapsible Column Hooping

Collapsible Column Hooping, for reinforcing concrete columns is shipped in the form of flat, circular coils of exact diameter and accurately spaced by means of special spacing bars. These coils spring automatically into a complete hooped column on cutting the small fastening wires.



Collapsible Column Hooping reduces freight bills, by securing a lower freight classification; makes possible a full-weight carload, owing to its compactness; does not become damaged in transit; assures absolute accuracy of construction; increases speed of installation; and saves expensive field labor.

Rib Bars are ordinarily used as vertical reinforcement in conjunction with Column Hooping.

Sizes of Collapsible Column Hooping

Shipped complete with two spacing bars.

Sizes of wire for hooping: $\frac{1}{4}$-inch, $\frac{5}{16}$-inch, $\frac{3}{8}$-inch, $\frac{7}{16}$-inch and $\frac{1}{2}$-inch diameter.

Diameters of Coils: 9-inch to 30-inch.

Pitch: $1\frac{1}{2}$-inch to 12 inches.

Hooping, where desired, can also be furnished in bundles, coiled to the correct diameter, and with separate spacing bars, ready for assembling in the field.

See Page 68 for Pieces under Direct Compression.

See Page 117 for Table of Safe Loads carried on hooped columns.

Rib Bars

The Rib Bar for reinforcing concrete is a special rolled section with a series of cross ribs so designed as to secure maximum grip on the concrete.

The Rib Bar is used principally as an auxiliary reinforcement to the Kahn Trussed Bar, Rib Metal and Hy-Rib. It is ideal wherever direct tension or compression stresses are to be resisted, for instance—the longitudinal bars in columns and the cross bars in slabs, also in domes, tanks, etc. It has a wide application for bridge abutments and massed concrete, where temperature, expansion and shrinkage stresses are to be resisted.

See pages 116 and 117 for Safe Loads on Columns.

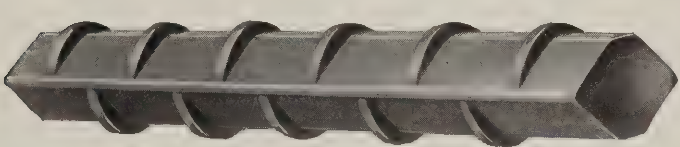


Table of Properties of Rib Bar

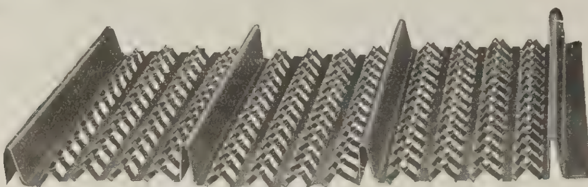
Size	Area	Weight per Lineal Foot
¼″	.0625 sq. in.	.213 lbs.
⅜″	.1406 sq. in.	.48 lbs.
½″	.2500 sq. in.	.86 lbs.
⅝″	.3906 sq. in.	1.35 lbs.
¾″	.5625 sq. in.	1.95 lbs.
⅞″	.7656 sq. in.	2.65 lbs.
1 ″	1.0000 sq. in.	3.46 lbs.
1⅛″	1.2656 sq. in.	4.38 lbs.

Hy-Rib

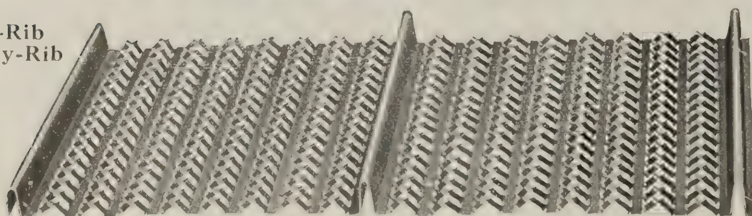
Hy-Rib is a steel sheathing, stiffened by rigid, deep ribs, formed from the same sheet of steel. Owing to the strength of these ribs, Hy-Rib does away with forms in concrete contruction. Hy-Rib is a unit of steel lath and studs.

Hy-Rib is supplied in either flat or curved sheets, for the construction of floors, roofs, walls, sidings, partitions, ceilings, furring, culverts, conduits, sewers, silos, tanks, etc.

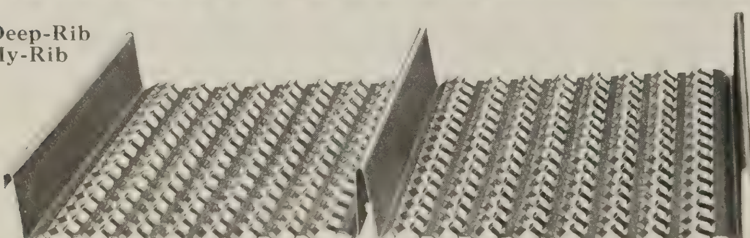
4-Rib Hy-Rib



3-Rib Hy-Rib



Deep-Rib Hy-Rib



Type of Hy-Rib	Gauge Nos. U. S. Standard	Spacing of Ribs	Height of Ribs	Width of Sheets
4-Rib Hy-Rib......	24, 26 or 28	$3\frac{1}{2}''$	$\frac{13}{16}''$	$10\frac{1}{2}''$
3-Rib Hy-Rib......	24, 26 or 28	7 ″	$\frac{13}{16}''$	14 ″
Deep-Rib Hy-Rib...	22, 24 or 26	7 ″	$1\frac{1}{2}''$	14 ″

Standard lengths: 6, 8, 10 and 12 feet.

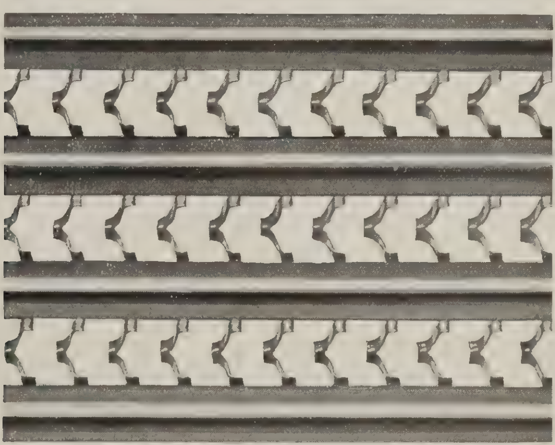
Intermediate and shorter lengths are cut without charge, but any waste is charged to the purchaser. Hy-Rib sheets interlock at sides and ends. In ordering, no allowance need be made for side laps. Allow 2 inches for end laps where splice occurs over supports; otherwise, eight inches.

See pages 98-99 for safe loads on Hy-Rib Slabs

Hy-Rib Hand-Book sent on request.

Rib Lath

Stiffest steel lath because of the beaded parallel ribs which span directly between the studs; provides a perfect clinch for the plaster owing to the improved form of expansion; requires least amount of plaster, with no dropping of plaster behind the lath; presents a uniformly flat surface to plaster against.



Beaded Plate Rib Lath

GRADE	Size of Sheets	Sheets per Bundle	Yards per Bundle	Weight per Sq. Yd.
Rib Lath No. 1A........	15¼"x96"	16	18	3.63 lbs.
Rib Lath No. 2A........	15¼"x96"	16	18	4.54 lbs.
Rib Lath No. 4A........	15¼"x96"	16	18	5.45 lbs.

Standard Rib Lath

GRADE	Size of Sheets	Sheets per Bundle	Yards per Bundle	Weight per Sq. Yd.
Rib Lath No. 1..........	20¼"x96"	12	18	2.74 lbs.
Rib Lath No. 2..........	20¼"x96"	12	18	3.42 lbs.
Rib Lath No. 4..........	20¼"x96"	12	18	4.10 lbs.

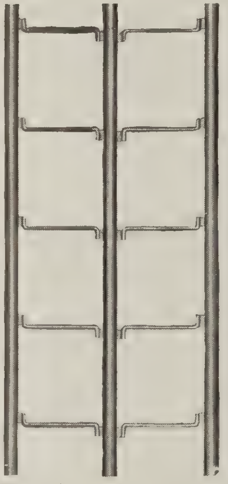
"B" Rib Lath

GRADE	Size of Sheets	Sheets per Bundle	Yards per Bundle	Weight per Sq. Yd.
Rib Lath No. 1B........	$24\frac{5}{16}$"x96"	10	18	2.28 lbs.
Rib Lath No. 2B........	$24\frac{5}{16}$"x96"	10	18	2.85 lbs.
Rib Lath No. 4B........	$24\frac{5}{16}$"x96"	10	18	3.42 lbs.

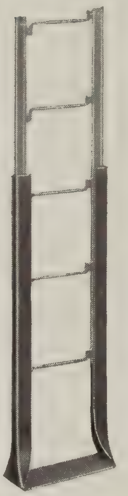
We recommend painted lath, but we can supply it without paint if desired.

Rib Lath Catalogue sent on request.

2¼", 3¼" and 4¼" wide



6¼" and 8¼" wide Rib Studs



Rib Stud Extensions

Detroit Steel Corner Bead.

Rib Steel Corner Bead No. 1.

Rib Studs

RIB STUDS—made of the highest grade of open-hearth steel—are open for the passage of conduits and pipes, and provide an uninterrupted air space between the two plaster surfaces. All lengths up to 18 feet.

RIB STUD EXTENSIONS—provide an adjustable attachment at floors and ceilings.

Steel Corner Beads

Our Corner Beads are galvanized after forming and furnished in lengths from 6 to 12 feet.

Detroit Steel Corner Bead—see illustration.

Detroit T-Rail Corner Bead—similar to Detroit Steel Corner Bead.

Detroit Solid Rail Corner Bead—made of special rolled section with punched web.

Rib Steel Corner Bead No. 1—see illustration.

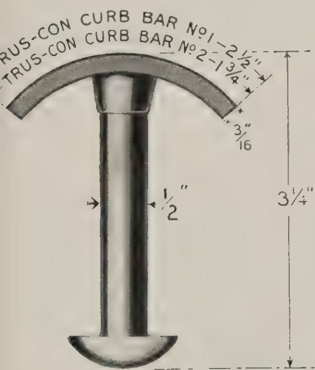
Rib Steel Corner Bead No. 2—similar to Rib Steel Bead No. 1.

Rib Feather-Edge Corner Bead—for fine, sharp corners.

Corner Bead pamphlet sent on request.

Trus-Con Curb Bars

Trus-Con Curb Bars are used to protect concrete curbs, entrance and interior columns, shipping platforms, step nosings, or any exposed concrete edges. Trus-Con Curb Bars consist of properly shaped steel plates with heavy anchor bolts that secure an absolutely positive hold in the concrete.



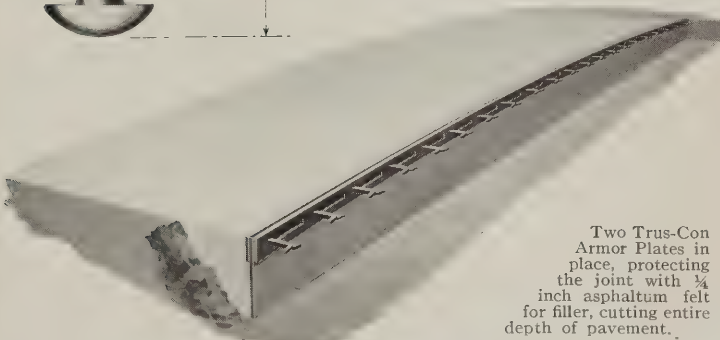
Trus-Con Curb Bars are made of highest grade open-hearth steel and heavily galvanized after forming.

Trus-Con Curb Bar No. 1

Plates $\frac{3}{16}$-in. thick, periphery 2½ in.
Anchor bolts ½ in. x 3¼ in.
Standard lengths 8, 10 and 12 feet.

Trus-Con Curb Bar No. 2

Plates $\frac{3}{16}$-in. thick, periphery 1¾ in.
Anchor bolts ½-in. x 3½ in.
Standard lengths 8, 10 and 12 feet.



Two Trus-Con Armor Plates in place, protecting the joint with ¼ inch asphaltum felt for filler, cutting entire depth of pavement.

Trus-Con Armor Plates

Trus-Con Armor Plates protect the expansion joints in concrete roads from chipping off and breaking down. The prongs formed from the plates are sheared at the ends to provide lugs for the positive anchorage of the plates to the concrete.

Trus-Con Armor Plates are made of highest grade open-hearth steel and are curved to pitch or crown of the pavement. Standard size of plate is 2½ inches wide by $\frac{3}{16}$ inches thick, in all reasonable lengths.

Catalogue on Bridges, Roads and Curbs sent on request.

Trus-Con Slotted Inserts in Ceilings, Beams and Columns.
Burroughs Adding Machine Co., Detroit.

Continuous Lines of Slotted Inserts in Kahn System Flat Ceiling.
Truck Dept., Packard Motor Car Co., Detroit.

Trus-Con Socket Inserts at Brown, Lipe, Chapin Co., Syracuse.
Note Kahn System Flat Ceiling with Brackets at Columns.

Trus-Con Pressed Steel Slotted Inserts

Trus-Con Slotted Inserts are used in concrete slabs, beams or columns for attaching Shaft Hangers, Fixtures, Sprinkler Systems, etc. They do away with expensive drilling into concrete after completion of the building.

Trus-Con Slotted Inserts are thoroughly imbedded into the concrete during the process of construction. Only the narrow slot flush with the concrete is seen in the completed work. The bolts can be moved along this slot to any desired location and are prevented from turning by special washers.

Standard lengths—18 in., 24 in., 36 in. and 60 in.

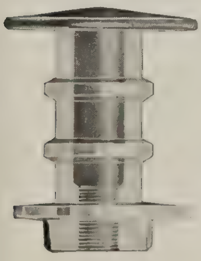
Lengths of suspension bolts (A)—2½ in. and 4 in.

Continuous Inserts of any desired lengths are formed by removing end caps and butting inserts end to end.

Kahn Adjustable Inserts

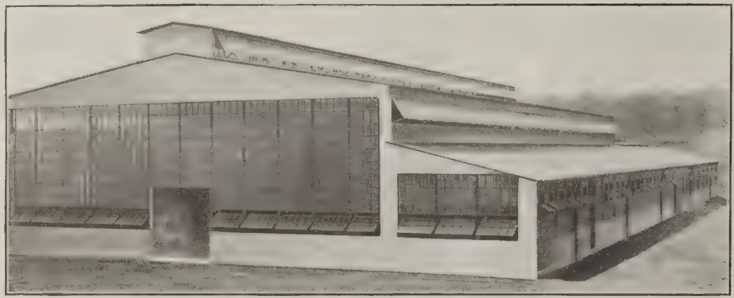
Are made of malleable iron and have the same simple method of application to concrete and adjustment for bolts as the slotted inserts, but without their wide range of adjustability.

Made in three sizes to accommodate ½″, ¾″ and ⅞″ bolts.

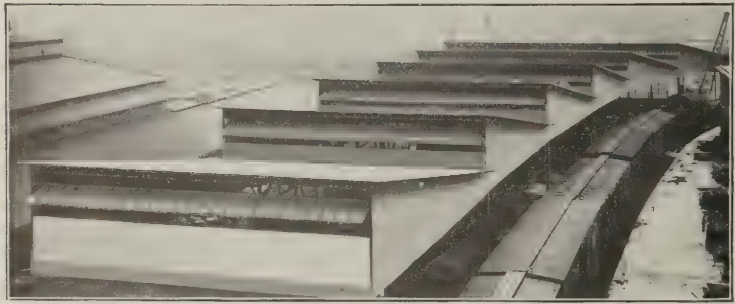


Trus-Con Socket Inserts

Are used for attachments which can be accurately located before occupancy. Made of malleable iron in three sizes, properly cored and threaded to receive ½″, ¾″ and ⅞″ bolts.



Pivoted United Sash in Side Walls.
Top-Hung Continuous United Sash in Monitors.



Center-Pivoted Continuous United Sash.
Note Increased Ventilation.

United Sash Partitions.
Movable and Save Space. United Steel Doors, (Sliding and Hinged) of all Types.

Vertical Sliding United Sash. Weber Electric Co., Schenectady, N. Y.

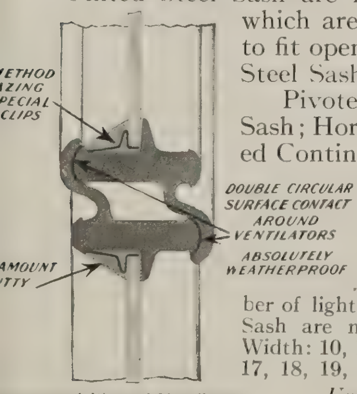
United Steel Sash

United Steel Sash are machine-built of deep rolled steel sections of great strength and rigidity. The joints are not weakened by cutting or punching away of the metal. Maximum daylight for interiors is assured, as there is practically no obstruction to the light at muntins, mullions, lintels or jambs. Large wide ventilators give perfect ventilation. All joints are carefully designed and fit tightly, shutting out the weather. Glazing is simplified by the use of spring clips.

United Steel Sash are manufactured in standard units, which are combined by means of mullions to fit openings of any desired size. United Steel Sash include all types of sash.

Pivoted Side Wall Sash; Vertical Sliding Sash; Horizontal Sliding Sash; Center Pivoted Continuous Sash; Top Hung Continuous Sash; Sliding and Swing Doors; Steel and Glass Partitions; Casement Sash, etc., etc.

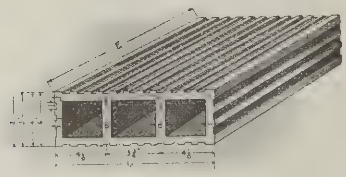
Standard units are three, four or five lights in width and any desired number of lights in height up to 15 feet. United Steel Sash are made for the following sizes of glass: Width: 10, 11, 12, 13, 14 or 15 inches. Height: 16, 17, 18, 19, 20, 21, 22, 23 or 24 inches.



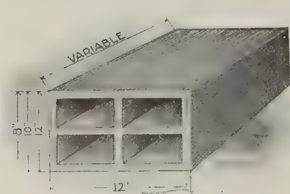
on around Pivoted Ventilator.

United Steel Sash Handbook on request.

Hollow Terra Cotta Tile



Partition Tile
2-, 3-, 4- and 6-inch



Floor Tile
8-, 10- and 12-inch

Partition and Floor Tile

Size	Weight
2″x12″x12″	13 lbs.
3″x12″x12″	15 lbs.
4″x12″x12″	18 lbs.
5″x12″x12″	20 lbs.
6″x12″x12″	22 lbs.
8″x12″x12″	27 lbs.
10″x12″x12″	32 lbs.
12″x12″x12″	36 lbs.

Also—
- Building Blocks
- Hollow Building Brick
- Jumbo Brick
- Book Tile
- Furring Tile
- Flat Arch Tile
- Fireproofing Tile
- Hollow Brick.

Stucco Blocks of all kinds including Jamb and Corner Blocks.

See pages 102 to 107 for Safe Loads of Hollow Tile Floors.

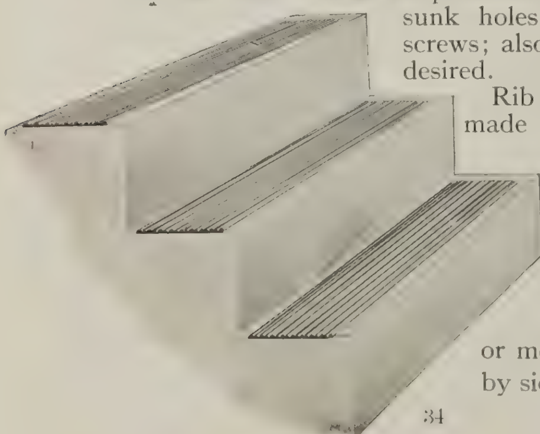
Tile catalogue on request.

Rib Steel Stair Treads

For Factories and Warehouses

Are adapted for stairways and landings, whether made of concrete, stone, slate or wood; or on structural steel frames. The deep ridges form an effective grip for the shoes and prevent slipping. The steel positively resists wear.

Rib Steel Stair Treads are provided with drilled, countersunk holes for fastening with screws; also with special lugs as desired.



Rib Steel Stair Treads are made of the highest grade open-hearth steel, in widths up to 6½ inches and in lengths up to 18 ft. Greater widths are secured by placing two or more of the treads side by side.

Trus-Con Chemical Products

Waterproofings—Dampproofings—Technical Paints

Trus-Con Waterproofing Paste: Mixed with gauging water to make concrete and cement waterproof.

Trus-Con Stone-Tex: A liquid cement coating, in colors, to dampproof and uniform exposed exterior walls of concrete, cement block, stucco and brick.

Trus-Con Por-Seal: A transparent liquid dampproofing for exposed exterior concrete, brick and cut stone walls.

Trus-Con Plaster Bond: A black dampproof coating for inside walls. Can be plastered on without furring and lathing.

Trus-Con Foundation Coat: Black hydrocarbon coating for dampproofing foundations, etc. Applied cold with a brush.

Trus-Con Stone Backing: Black coating for unexposed sides of cut stone. Protects against stain from mortar.

Trus-Con Ironite Flooring: An iron powder for finishing cement floors with an ironized wear-resistant surface.

Trus-Con Floor Enamel: A tough, dustless, washable coating for cement floors. In colors. Applied with a brush.

Trus-Con Asepticote: A flat, washable coating, in colors, for interiors of plaster, wood, concrete, brick, metal, etc.

Trus-Con Sno-Wite: Finest quality pure white enamel for interior decoration.

Trus-Con Industrial Enamel: White enamel coating for interior use in factories, power-houses, warehouses, etc.

Trus-Con Hospital Enamel: Durable, fume-proof, white gloss coating. Can be washed with antiseptic solutions.

Trus-Con Dairy Enamel: A sanitary white enamel for creamery and dairy walls and ceilings. Can be scrubbed freely.

Trus-Con Edelweiss: A weather-proof white gloss enamel for exterior walls of all kinds.

Trus-Con Packing House Enamel: A white gloss, steam resisting, sanitary coating for packing houses, laundries, etc.

Trus-Con Roof-Seal: For preserving and protecting shingle, felt and metal roofs.

Trus-Con Shingle Stains: Creosote stains for preserving and coloring shingles and wood siding.

Trus-Con Bar-Ox: Protective coatings of various formulae: **No. 7** for structural steel, bridges, etc.; **No. 14** for brewing and ice making coils; **No. 21** for stacks, boilers and hot metal surfaces; **No. 28** for acid-proofing metal surfaces.

Trus-Con Hand-Book sent on request.

Fire starting in the fourth story of the concrete building, of Dayton Motor Car Co., Dayton, Ohio, was prevented from spreading to other floors by the concrete construction. Three floors of the adjoining mill-constructed building were completely destroyed. Repairs to the Kahn System concrete building amounted to less than $500.00, the cost of replacing the wooden window sash.

Fireproofness

In San Francisco, Baltimore and other disastrous fires, reinforced concrete has demonstrated its superiority. In the severe tests of building departments, such as New York City, reinforced concrete floors carrying heavy loads have withstood continuous temperatures of 1700 degrees Fahrenheit, followed immediately by streams of water from a fire hydrant. In many actual fires, concrete has withstood intense heat without damage. The rigidly connected reinforcement of the Kahn System makes concrete practically immune to the effects of fire.

Load test of over two tons (4000 lbs.) on every square foot of full sized panel of Nicol, Dean & Gregg Building, St. Paul. Bar iron, standing on end, is stored on the floors of this Kahn System Building.

Strength

Rigid requirements of exacting engineers, severe tests of Government building departments, and actual use in thousands of structures have demonstrated the superior strength, rigidity and load-carrying capacity of reinforced concrete. Its additional factor of safety, beyond all allowance in calculation, has been shown in numerous examples of overloading and accidental shocks. The Kahn System with its rigidly connected reinforcement assures maximum strength and safety.

Doubling the floor space by attaching machinery to ceilings and floors. A typical example in the 38-acre plant of Packard Motor Car Co., Detroit, showing the vibration-resisting qualities of the Kahn System Reinforced Concrete.

Vibration Resistance

Reinforced concrete withstands the shocks of vibration. In hundreds of buildings, rapidly moving machinery is attached both to concrete ceilings and floors with hardly a noticeable tremor. Large, pounding printing presses are frequently located on the upper floors of high concrete buildings. Reinforced concrete bridges, carrying the modern mogul locomotives, are built by railroad companies everywhere. Authorities on earthquakes recommend reinforced concrete. The Kahn System with its rigidly connected reinforcement is essential for resisting vibration in concrete construction.

Every part of the machinery and the product is perfectly lighted by the use of United Sash in windows, assuring maximum efficiency of employees and highest quality of product. Interior of Beechnut Packing Co., Canajoharie, N. Y. This modern sanitary plant is built Kahn System Reinforced Concrete.

Daylighting

Daylighting prevents accidents in factories, as shown by carefully prepared statistics. A daylighted interior insures the use of all floor space, a greater output per man, better quality of work, less waste of material, saving of artificial light and greatest efficiency. Buildings constructed with Kahn Building Products and equipped with United Steel Sash in Windows have maximum light, making the interior like a protected portion of the great outdoors.

Attractive administration building of the Hudson Motor Car Co., built Kahn System Reinforced Concrete. Hundreds of other pleasing designs, built with any kind of material for the exterior, can be adopted.

Appearance

An attractive appearing plant bespeaks the progressiveness of the manufacturer, and reflects its character on his products. Cheerful surroundings materially increase the efficiency of the employees. A beautiful, clean cut, modern building costs no more than other kinds, but pays large dividends annually to the owner. Simple, strong, impressive designs are possible with the Kahn Building Products at nominal expense.

Economy

Kahn Buildings are low in first cost, much less than other types of fireproof construction and little if any more than burnable, short-lived structures. Kahn Buildings make money for owners every year in the saving of insurance, absence of repairs, increased life of building, greater efficiency of employees, reduction of waste and insurance against crippling of operations. Look over the accompanying table, in which a very conservative allowance is made for the vaious items of saving.

Reinforced Concrete More Economical than Mill Construction

(From Engineering Magazine, August, 1909)

Assume a building costing complete $100,000; contents equal to the cost of the building; and that it is used for general manufacturing purposes. The yearly charges against each building are:

Initial Cost of Building	Mill Construction $100,000	Reinforced Concrete $110,000
Interest at 6%	$ 6,000	$6,600
Taxes at 1%	1,000	1,100
Insurance on building at 75c per $100 value	750	At 25 cents, 275
Insurance on contents at $1 per $100 value	1,000	At 80 cents, 800
Depreciation on building at 1¼%	1,250	At ½% 550
Results of vibration—Assume $450	450	Chargeable to mill bldg. only
Increased light—1% increase in efficiency of labor. Assume labor equals ½ value of contents—$50,000	500	Chargeable to mill bldg. only
Vermin losses	100	Chargeable to mill bldg. only
Protection against business losses due to fire at ½% on value of 30% of building and contents, or $60,000	300	Applies to mill bldg. only.
Total Yearly Charges	$11,350	$9,325

Annual Saving of Concrete Over Mill Building—$11,350—$9,325=$2,025.00

Therefore a concrete building costing originally 10% more than a mill building saves 2% each year. Capitalize this saving at 6% and it represents $33,750. In other words a concrete building costing $143,750 is just as economical as a mill building costing $100,000, i. e., an owner could afford to pay 43¾% more for a concrete building.

Comparative Cost of Wood Mill Construction and Reinforced Concrete Buildings

Compiled by J. P. H. Perry

Kind	Place	Size	Stories	Load Lbs. Per Sq. Ft.	Cost Wood Building	Cost of Concrete Building	Concrete Per cent More or Less than Wood	Bid or Estimate
Factory	Detroit		3	300	$ 28,000	$ 28,500	1.5 more	Bid
Factory	Jersey City	60x140	5	200	52,000	56,000	7.1 more	Bid
Factory	Grand Rapids				85,300	86,000	1.3 more	Bid
Factory	Fall River	112x112	4		74,000	82,500	10.3 more	Bid
Factory	Manchester	45x100	5		52,000	72,000	27.7 more	Estimate
Warehouse	Boston	20x155	9		212,500	196,000	6.3 less	Bid
Warehouse	Jersey City	38x 94	6	200	39,000	43,000	9.3 more	Bid
Warehouse	Pittsburgh	100x120	4		61,500	63,600	3.3 more	Bid
Warehouse	Nashua	100x200	8		117,000	131,000	10.7 more	Bid
Press Building	Cincinnati						4.0 more	Bid
Bakery	Cincinnati	60,000 s. f.		300	64,000	62,500	2.3 less	Bid
Shop	Cincinnati				16,000	19,100	16.2 more	Estimate
Shop	New England				65,800	69,500	5.2 more	Estimate

Above table gives actual bids and estimates on manufacturing buildings showing comparative costs in wood mill construction and reinforced concrete.

—From "Comparative Costs of Buildings," by H. G. Tyrell, Engineering Magazine, June 1912.

Comparative Cost of Buildings in Reinforced Concrete and in Structural Steel, Fireproofed.

Kind	Place	Size, Feet	Stories	Load Lbs. Per Sq. Ft.	Cost of Reinforced Concrete	Cost of Steel	Re-Constructed More or Less than Steel Per cent.	Bid or Estimate
Factory........	Des Moines....	66x132	6	200	$ 60,650	$ 69,750	13.0 less	Estimate
Factory........	Fairmount.....	50x100	3	200	25,000	28,000	10.7 less	Bid
Warehouse.....	Brooklyn......	140x190	10	200	250,000	280,000	10.7 less	Bid
Office..........	St. Louis.......	86x120	8	70	170,000	184,000	7.6 less	Bid
Office..........	Cincinnati.....	....	17	70	....	....	4.0 less	Bid
Mill...........	Boston.......	....	3	....	278,000	286,400	2.8 less	Bid
Store..........	Indianapolis...	71x120	6	125	89,500	96,000	6.8 less	Bid
Hospital.......	Indianapolis....	....	6	....	793,000	823,000	3.6 less	Bid
Hotel..........	St. Louis.......	120x140	8	70	171,000	184,000	7.0 less	Bid
Hotel..........	St. Louis.......	....	11	70	290,000	304,000	4.6 less	Bid
Factory........	Ohio..........	....	12	200	40,000	Less	than steel.	
Loft...........	Springfield.....	105x283	9	150	280,000	320,000	12.5 less	Bid

Above table gives actual bids and estimates showing the comparative cost between reinforced concrete construction and structural steel fireproofed. Note that reinforced concrete is considerably cheaper.

—From "Comparative Costs of Buildings," by H. G. Tyrell, Engineering Magazine, June 1912.

Specifications for Reinforced Concrete

General

Where shown on drawings or called for in the specifications, Reinforced Concrete shall be used.

No system of reinforced concrete will be considered which is not of recognized standing, and which has not been used successfully for five years on important work.

Work may be carried on only under foremen and superintendents who have had thorough experience in this class of work.

Structural Drawings

Parties submitting proposals must furnish drawings indicating their method of calculation, arrangement and nature of the steel reinforcement for the various structural members indicated, and no proposition will be considered without such calculations and drawings.

Materials

Samples of all materials must be submitted and approved by the Architects before same are used. All materials rejected for this work must be immediately removed from the vicinity.

Cement

1. All cement furnished for this work is subject to inspection and tests as hereinafter specified.

2. Inspection and tests shall be conducted by Laboratory selected by Architect and at the cost and expense of Contractor.

3. All inspection and sampling shall be made by the Laboratory at the point of manufacture, sending samples to its laboratory for tests, and only cement that has been previously accepted will be allowed on the work.

4. In cases where special conditions make inspection at factory impracticable, inspection at the job may be substituted, subject to approval of Architect. When job inspection is permitted, the cement shall be delivered at the job at least two weeks before required for use, so as to allow ample time for necessary tests by the Laboratory, and proper care taken to separate the individual cars that they can be easily identified if found unsatisfactory. A suitable place must be provided for the storage of all cements, and no cement shall be used that has absorbed sufficient moisture to cause the

cement to granulate or become lumpy when thoroughly dried.

5. The cement will be accepted at the work packed in stout paper, cloth or canvas sacks. Each package shall be plainly labeled with the name of the brand and manufacturer. Any package broken or containing damaged cement may be rejected or accepted as a fraction package at the option of the Engineer in charge of the work.

6. The cement shall be tested in strict compliance with the methods specified in the Standard Specifications of the American Society for Testing Materials, and only cement that passes all requirements of these specifications shall be used.

Fine Aggregate

The sand, or fine aggregate, shall consist of grains of any moderately hard rock passing, when dry, a screen having four meshes to the linear inch. It shall be clean, well graded from coarse to fine, with coarse particles predominating, and free from vegetable loam and other deleterious matter.

All sand, to be approved, must show when mixed with Portland cement in proportion of one (1) part of cement to three (3) parts of sand, by weight, a tensile strength of at least seventy per cent (70%) of the strength of a one to three (1:3) mortar of the same consistency made with the same sample of cement and standard testing sand.

Coarse Aggregate

Coarse aggregate shall consist of inert material such as crushed stone or gravel which is retained on a screen having one-quarter inch (¼″) diameter holes. The particles shall be clean, hard, sound, free from any deleterious matter, and well graded from coarse to fine, to yield concrete of the greatest natural density. The maximum size of the coarse aggregate shall be such that it will not separate from the concrete in placing and will not prevent the concrete fully surrounding the reinforcement or filling out all parts of the forms.

All coarse aggregate shall be well wetted immediately before being used.

In case gravel is used without screening, a careful examination shall be made to determine the exact ratio of fine to coarse aggregate, separating on a number four (No. 4) sieve, and the gravel used with the cement in proportion to maintain the correct ratio of cement to fine aggregate as required for the particular work in which the concrete is to be used.

Proportions

All concrete for slabs and beams shall be proportioned of one (1) part of Portland cement, two (2) parts of fine aggregate and four (4) parts of coarse aggregate.

All concrete for columns shall be proportioned of one (1) part of Portland cement, one and one-half ($1\frac{1}{2}$) parts of fine aggregate and three (3) parts of coarse aggregate.

Mixing of Concrete

Proper provisions must be made to provide for the correct measurement and proper proportioning of all concreting materials, including water. All water shall be free from oil, acid, strong alkalies or vegetable matter. All concreting materials shall be mixed until the cement is uniformly distributed throughout the mass and the concrete uniform in color. Sufficient water must be added during the mixing to produce a concrete that will flow when agitated, but not so wet as to permit separation of the materials in transferring from the mixer to the work.

A competent foreman must be in constant attendance at the mixer, to approve the proportions of materials placed in the mixer and the finished batch before leaving the mixer.

Placing the Concrete

All concrete must be placed in the work immediately after mixing and churned and agitated with suitable tools in such a manner as to remove all voids and thoroughly compact and densify the mass. All concrete showing a partial set before placing shall not be used in any portion of the work, but removed from the job. When concreting is once started, it shall be carried on as a continuous operation until the pouring of the section or panel is completed. If for any reason the concreting should be stopped, the greatest care must be taken to stop the work at such a point that the joint formed will not weaken the member structurally.

All columns are to be filled a sufficient time previous to the concreting of the floor construction to allow the concrete in the columns to settle to a permanent position. The pouring of the columns must be one continuous operation to the level of the bottom of the girder or beam supported by it.

In pouring, the concrete is to be kept well stirred or puddled to prevent voids and honey-combing.

The concrete in all beams shall be placed so as to be perfectly monolithic with the adjacent slab.

When a section of the floor is once poured, it shall be left entirely undisturbed until the concrete has thoroughly set.

The surface of concrete which has set, and upon which new concrete is to be laid, shall be thoroughly cleaned to remove all foreign and latent materials, and coated with a creamy mixture of neat cement and water, immediately before placing new concrete.

The Superintendent in charge of the work shall mark in ink on the drawings, the time and date of the pouring of the different columns, girders and floor slabs.

Reinforcing Steel

Steel shall be medium, open-hearth steel to be rolled from new stock and to meet the Manufacturers' Standard Specifications.

Ultimate strength, 60,000 to 70,000 pounds per sq. inch.

Elastic limit, not less than half the ultimate strength.

$$\text{Percentage of elongation} = \frac{1{,}400{,}000}{\text{Ultimate strength of steel.}}$$

Bending test, 180 degrees to a diameter equal to thickness of piece tested without fracture on outside of bent portion.

All steel shall be free from paint, oil or heavy rust or scale.

All reinforcing steel shall be furnished by the Trussed Concrete Steel Company, Detroit, Mich., in accordance with the Kahn System of Reinforced Concrete.

The main reinforcement for joists, beams, girders, or any members subjected to combined bending moment and shear shall consist of Kahn Trussed Bars in which the shear members are inclined at an angle of 45 degrees and rigidly connected to the main tension member. There shall be sufficient shear reinforcement so that the concrete shall not be obliged to resist either direct tension or shear greater than 60 pounds per sq. in. Minimum depth of beams should not exceed 1/15 of the clear span.

Reinforcement for floor slabs shall consist of Kahn System Reinforcing Steel as indicated on plans. Minimum depth of slab shall not exceed 1/30 of the clear span.

Vertical reinforcing for columns shall consist of Rib Bars either used in conjunction with built-up column hooping or

thoroughly tied at intervals of 12 inches as required by the design. Least width of column shall not exceed 1/15 of its unsupported length.

Design of Reinforced Concrete

All reinforced concrete work shall be designed in accordance with the requirements of the Trussed Concrete Steel Company, Detroit, and shall conform to local regulations, governing building construction.

Tile and Concrete Floor Construction

When tile and concrete construction is used for floors, the tile shall be sound, hard-burned tile of uniform size. The concrete joists shall be parallel, in perfect line and of the uniform width called for on plans. The concrete on top of the tile must be poured at the same time as the concrete in the joists and be of the same mixture. The tile shall be thoroughly soaked with water before pouring the concrete.

Centering and Forms

All forms must be strong and stiff, true, out of wind, practically unyielding and sufficiently tight to hold the liquid mortar without leakage. Interior dimensions must conform to the dimensions of the concrete specifications shown upon the approved plans. All forms for beams, girders and lintels shall be so designed that at least one side may be removed without disturbing the bottom portion of the form and its supports. All posts supporting forms for slabs, beams and girders must rest upon wedges which may be loosened or removed without producing undue stress in the floor system. The forms for all columns must provide an opening at the bottom for cleaning and for adjustment of the steel. The opening is closed before pouring concrete. Columns over 14′ in height and under 18″ square shall have an intermediate opening or pocket, and the pouring started therefrom. All shavings, chips, sawdust and other forms of foreign matter shall be removed before the concrete is placed in the forms.

Removal of Centering

Centering shall not be removed until the concrete has thoroughly set and is of sufficient strength to carry its own weight together with whatever live load is liable to come on the construction. No false work shall be removed without the approval of the architect or engineer in charge.

Before removing the temporary supports of the beams and girders, at least one side of the adjacent column form and one side of the girder form shall be removed in order to expose the concrete to view and permit thorough examination and determination of the condition of soundness and hardness. Beams and girders shall remain supported for at least two weeks after all other false work has been removed during favorable conditions for hardening, and columns shall not be given their full loading in less than five weeks.

Freezing Weather

Placing concrete in freezing weather shall be avoided whenever possible and, when necessary, sufficient precaution shall be taken to prevent the concrete freezing—such as heating the building with salamanders, covering the concrete with sawdust, straw or manure, and heating the materials. All concrete which is frozen shall be removed. The centering shall not be removed until the concrete has thoroughly set and aged.

Hot Weather

All concrete laid during the hot weather shall be thoroughly wet with clean water at least twice each day during the first week after placing.

Precautions on Removing Centering and Concreting During Freezing Weather

The most exacting care must be exercised in removing centering, to be absolutely certain that the concrete is properly set and hardened. This is particularly true during the fall and winter months, when weather conditions are not favorable for the normal setting and hardening of concrete.

During summer months with warm temperatures, the hardening of concrete occurs at normal rate, and while the strength of the concrete should be fully determined before any centering is removed, the same extraordinary care is not so important as during colder months.

Concrete that will harden at normal rate above a temperature of 50° F. will be slowly retarded in setting with temper-

atures approaching freezing. At 40° F. the cement remains quite inactive and a great deal longer time must be permitted for the hardening at the much slower and retarded rate.

It is recommended in placing concrete, particularly in the colder weather, to make provisions for pouring a number of 6″ test cubes at the same time the concrete is placed. These test cubes should be left in the forms and kept under exactly the same conditions of weather exposure as the concrete, so as to be certain that the rate of hardening proceeds precisely the same as in the structural concrete.

A sufficient number of such test cubes should be made so that duplicates may be crushed at intervals, to determine by actual test the exact development of strength in the concrete. Do not consider the removing of any forms until the compressive strength of the concrete indicates that it is sufficiently hardened to permit removing the forms with perfect safety. In testing the cubes care should be taken to conduct the compressive test as soon as the cubes are brought into the laboratory and not permit them to remain in a warmer temperature for any great length of time, as this would yield results higher than the actual strength of the the concrete in the work.

In placing concrete in winter, it is highly important that the aggregate used be entirely free from frost and preferably should be heated, so as to provide with the heated water a resultant temperature in the concrete as placed of about 100° F. This initial temperature, supplemented by the heat developed in the crystallization of the cement, will insure good normal setting, provided that the concrete is so protected as to avoid too rapid radiation and loss of heat.

To keep gravel free from frost and in good working condition, perforated steam pipes should be forced at intervals into the pile of gravel and fed with a good supply of steam. When available, heavy canvas should also be placed over the gravel so as to avoid rapid radiation of the heat contributed by the inserted steam pipes.

As a further precaution, in the very coldest and most uncertain weather, it is recommended to insert in the soft concrete as poured, a small copper tube about 3/8″ in diameter, to accommodate a laboratory tube thermometer. The end of the pipe inserted in the concrete should be closed with a cork to prevent the concrete running into the tube, while the

thermometer should be held in the tube through a perforated cork. A temperature reading should be taken as soon as the concrete is placed and also at regular intervals, and careful record kept of the actual temperatures of the concrete, particularly during the first 72 hours.

In any case where it is known that concrete has been frozen throughout or fairly deep into the mass, it should be removed and replaced with new concrete. If the frost has penetrated the concrete to only a depth of ⅛ or ¼″, it will not be serious, but every possible method should be employed to determine that the penetration of the frost is limited to this depth.

Where the concrete has been slightly frozen it should be enclosed and heat provided with salamanders to draw the frost out of the concrete and permit very careful examination to be made to ascertain to what extent the concrete has been injured. Under no conditions remove the forms from concrete that has been at all frosted, until heat has been provided of sufficient duration and temperature to draw all frost and moisture out of the concrete, so that a fair examination can be made and its actual condition determined.

The physical examination of concrete before the forms are removed should not be confined to the top, but small sections of the forms should be removed from the underside and the exact condition of the concrete carefully observed on striking with a hammer. Concrete that is properly set and hardened should ring with the distinct clearness characteristic of a good, hard, dense mass. If there is any apparent deadness or dullness to the concrete on striking with a hammer, the removal of forms should be delayed until the concrete has sufficiently hardened to resound with a good, sharp, clear ring.

If the superintendent in charge of the work is not fully experienced in examining concrete, so as to be positively certain regarding the strength necessary for the removal of forms, the services of experienced men should be provided to carefully examine the concrete and pass upon the advisability of removing the centering.

Under no circumstances should an attempt be made to remove any centering until it is absolutely and positively determined beyond any question of doubt that the strength of the concrete has developed sufficiently to entirely avoid any sagging or deflection in the members and any possible failure.

Crushing Strength of Concrete

The compressive strength of concrete varies with the materials, the age, the mixture and climatic conditions, and where possible should be determined by tests. Otherwise the following values submitted by the Joint Committee on Concrete and Reinforced Concrete may be considered as very conservative for good materials and good workmanship.

Table of Strengths of Different Mixtures of Concrete 28 Days of Age
(In pounds per square inch)

AGGREGATE	Mixtures: Cement, Sand and Aggregate				
	1:1:2	1:1½:3	1:2:4	1:2½:5	1:3:6:2
Granite, trap rock	3300	2800	2200	1800	1400
Gravel, hard limestone and hard sandstone	3000	2500	2000	1600	1300
Soft limestone and sandstone	2200	1800	1500	1200	1000
Cinders	800	700	600	500	400

Cinder concrete should never be used in the main members of the structure, such as girders, beams, columns, and footings, because of its variation in strength and the difficulty of securing material of uniformly, satisfactory quality. Cinder concrete may be used for fire protection and sometimes for short-span slabs or arches between steel beams.

The tables throughout this book are invariably based on the use of stone concrete, with 1:2:4 *mixture for slabs, beams and footings, and* 1:1½:3 *mixture for columns.*

Modulus of Elasticity

Report of Joint Committee on Concrete and Reinforced Concrete

"It is recommended that in computations for the position of the neutral axis and for the resisting moment of beams and for the compression of concrete in columns, the value of the modulus of elasticity of concrete be assumed as:

(a) One-fifteenth of that of steel, when the strength of the concrete is taken as 2200 lbs. per sq. in. or less.
(b) One-twelfth of that of steel, when the strength of the concrete is taken as greater than 2200 lbs. per sq. in. or less than 2900 lbs. per sq. in., and
(c) One-tenth of that of steel, when the strength of the concrete is taken as greater than 2900 lbs. per sq. in.

N. B.—The value of 1/15 is used throughout this book.

Allowable Stresses, Methods of Design, Etc.

Monolithic Action

It is difficult in reinforced concrete work to adopt an arbitrary theory of design and fixed working stresses, which shall apply to structures of every class. To design correctly, each particular problem should have individual attention and methods of design adopted accordingly. Concrete work being built monolithic should be treated accordingly and not analyzed into separate units, as is done with ordinary materials where units are dealt with. The great additional strength of a monolithic construction of this kind is apparent. If any particular part of a floor is heavily loaded, the floor adjacent will come to its assistance and will distribute the concentrated loading over a large area of floor space.

Effect of Vibration

In the case of vibratory loadings, such as caused by moving machinery, actual experiments have shown that concrete absorbs the shock better than any other building material. The Kahn System has been used in many such structures and there is not the least tremor noticeable when machinery is in operation.

Strength Due to Arch Action

Reinforced Concrete, when built continuously over a large floor area, has great additional strength due to interior arch action in the concrete. This arch action will in itself carry considerable load without causing any stress in the reinforcement. This, of course, is more marked in a floor where the depth is large compared with the span, than where the reverse is true. It would, therefore, seem proper to design a deep floor, supported on all sides by similar construction, with greater working stresses than a thin, isolated panel unsupported by adjacent construction.

Other points to be considered in this connection are the quality of the materials and the grade of workmanship.

The methods of design, stresses and tables presented in this book have been purposely made very conservative to avoid misuse and may be varied to meet the special conditions or requirements of the designer. The additional strength due to monolithic construction, arch action, and tensile strength of concrete, is entirely neglected in the calculations and thus an additional factor of safety is given to all work designed on this basis.

Theory of Reinforced Concrete Work

The following theoretical analysis is based on the use of what is known as the "Straight Line" formula. This is a formula which is daily becoming more generally adopted and is embodied in the building requirements of almost all American cities and those of the Prussian Government. It is recommended by the most authoritative text books and has the advantages of simplicity and directness. It corresponds with the accepted theory of flexure as applied to other materials and is admittedly correct within allowable working stresses. If the theory errs at all, it errs on the side of safety.

This theory is based on the following assumptions:

1st. *A section plane before bending remains plane after bending; that is, the stress on any fibre is directly proportional to its distance from the neutral axis.*

2nd. *The tensile strength of the concrete is entirely neglected.*

3rd. *There are no initial strains in the beam.*

4th. *All shearing strain is cared for and there is no slipping between the concrete and the steel.*

5th. *The modulus of elasticity of concrete in compression is constant.*

Moment of Resistance of Simple Beam

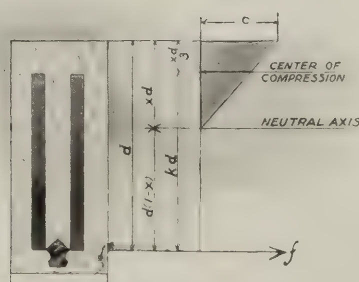


Fig. No. 1.

Referring to figure:

d = distance from extreme compressed fibre to center of steel.
x d = distance from the extreme compressed fibre to the neutral axis.
x = ratio of depth of neutral axis to depth (d) of steel.
k d = distance from center of compression of concrete to center of steel.
k = ratio of this distance to depth of beam (d).
b = breadth of beam.

$m = \frac{E_s}{E_c} = \frac{\text{modulus of elasticity of steel.}}{\text{modulus of elasticity of concrete.}}$

A_s = area of steel reinforcement.

p = ratio of area of steel to area of concrete $= \frac{A_s}{bd.}$

c = compressive stress in extreme fibre of concrete.

f = tensile stress in steel.

RM= moment of resistance of beam.

BM= bending moment.

The total compression in the beam must equal the total tension. Equating these forces:

$\frac{1}{2}$ c b x d = p b d f or

$$\tfrac{1}{2}\,\mathbf{c\,x = p\,f} \qquad [1]$$

According to assumption 1st above

$$\frac{\mathbf{c}}{\mathbf{f}} = \frac{\mathbf{x}}{\mathbf{m\,(1\text{-}x)}} \qquad [2]$$

Combining equations [1] and [2]

$\frac{1}{2}x^2 = m\,(1\text{-}x)\,p$, whence

$$\mathbf{x = -pm + \sqrt{(pm)^2 + 2\,pm}} \qquad [3]$$

Again combining [1] and [2]

$$\mathbf{p = \frac{1}{2}\,\frac{c^2\,m}{f\,(f + cm)}} \qquad [4]$$

The stress strain curve being a straight line, the center of compression is located $\frac{2}{3}$ x d above the neutral plane.

Taking moments about the neutral axis:

$$\mathbf{RM = \left[\frac{1}{3}\,c\,x^2 + p\,f\,(1\text{-}x)\right] bd^2} \qquad [5]$$

Taking moments about the center of the steel:

$$\mathbf{RM = \frac{c\,x\,bd^2}{2}\left(1 - \frac{x}{3}\right) = k\,\frac{c\,x\,bd^2}{2}} \qquad [6]$$

Taking moments about the center of compression in the concrete:

$$\mathbf{RM = \left(1 - \frac{x}{3}\right) d\,A_s\,f = k\,d\,A_s\,f} \qquad [7]$$

From equation [7] it is at once evident that the moment of resistance of a concrete beam is dependent only on the factor (*k*), the area of reinforcement, the depth of the beam, and

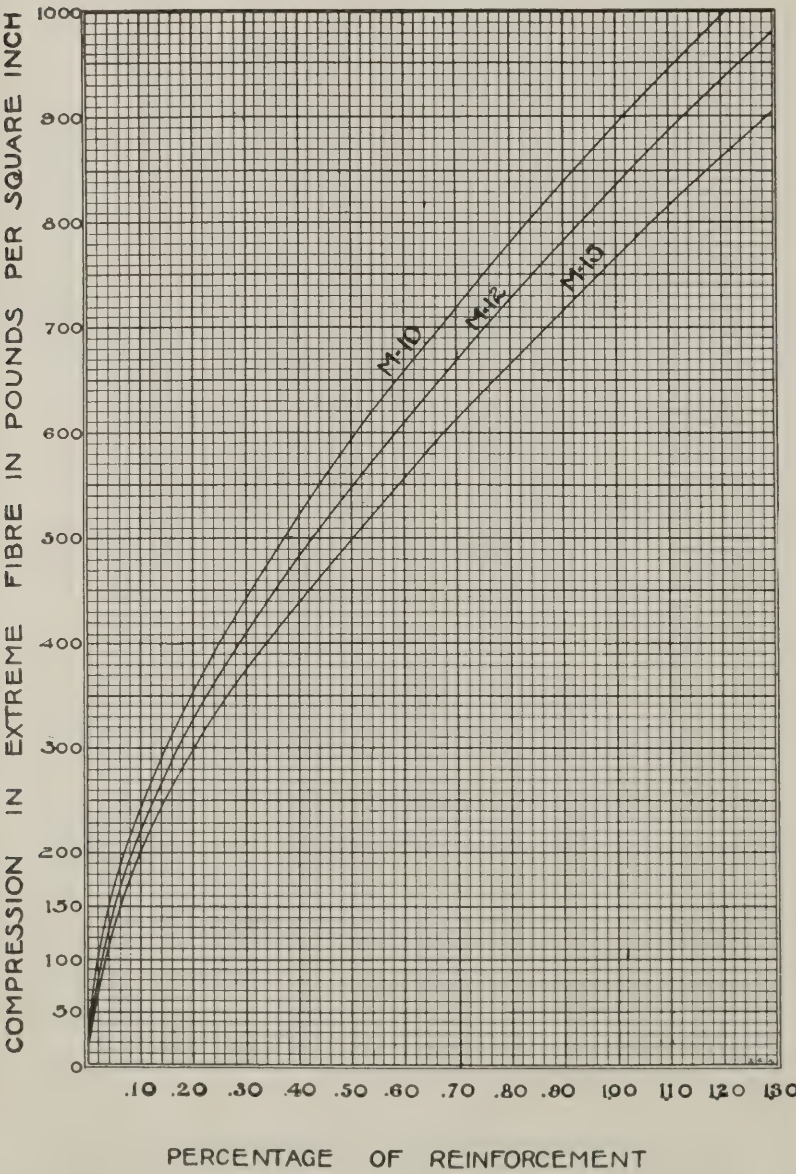

COMPRESSION IN EXTREME FIBRE IN POUNDS PER SQUARE INCH
1000
900
800
700
600
500
400
300
200
150
100
50
0
M-10
M-12
M-15
.10 .20 .30 .40 .50 .60 .70 .80 .90 1.00 1.10 1.20 1.30
PERCENTAGE OF REINFORCEMENT

Fig. No. 2.

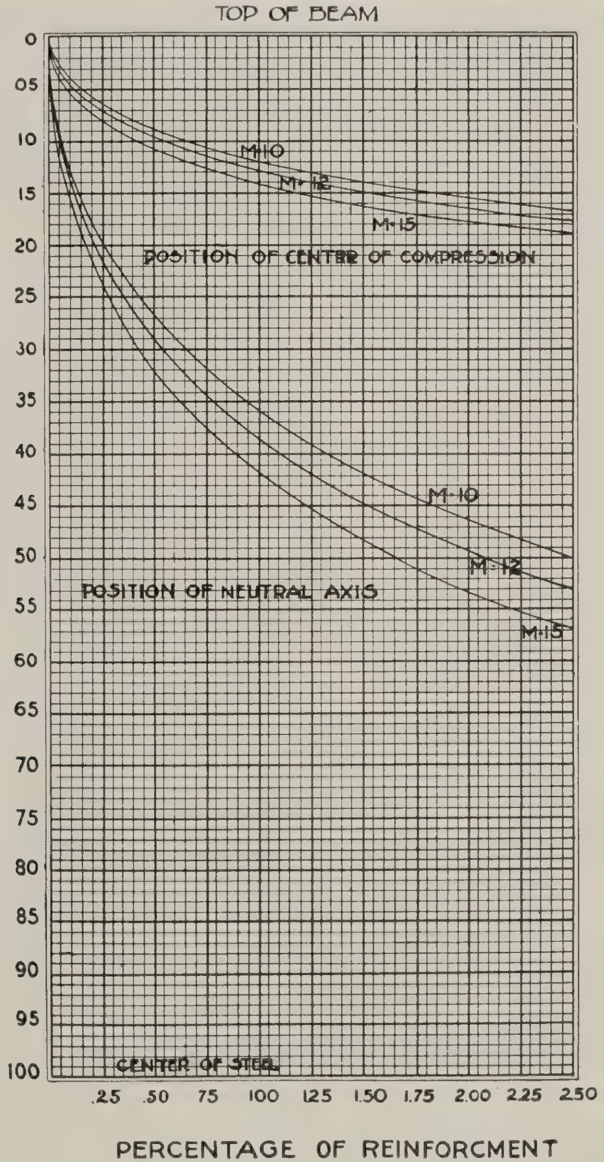

TOP OF BEAM
M-10
M-12
M-15
POSITION OF CENTER OF COMPRESSION
M-10
M-12
M-15
POSITION OF NEUTRAL AXIS
CENTER OF STEEL
0
05
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
.25 .50 75 100 125 1.50 1.75 2.00 2.25 2.50
PERCENTAGE OF REINFORCMENT

Fig. No. 3.

the allowable stress in the steel, with this important proviso —*that the allowable compressive stress in the concrete is not exceeded.* This allowable stress will not be exceeded if the percentage of steel is kept below the value as determined by equation (4). It will be seen from equation (4) that if we assume a value for (f) equal to 16,000 pounds per sq. in., and also values for (m), that curves can be plotted showing the relation between the percentage of the metal and the compressive stress in the concrete.

In Figure 2, page 56, these curves are shown for values of (m) equal to 10, 12 and 15 and based on a stress in the steel equal to 16,000 pounds per sq. in.

From these tables it will be seen that if the percentage of steel does not exceed 1 per cent. for good rock concrete, there is no danger of the concrete failing by compression.

The factor (kd) in equation (7) is the distance between the center of compression of the concrete and the center of the steel. It depends entirely for its value on the position of the neutral axis. From the equation (3) it is seen that the position of the neutral axis is dependent entirely on the percentage of the reinforcement and the values of (m).

Again assuming (m) equal to 10, 12 and 15, in equation (3), curves as shown in figure 3 on page 57 are drawn showing the position of the neutral axis for various percentages of metal. From these curves the value of the factor (k) are readily obtained and are shown properly plotted in the same figure. An inspection of these curves will show at a glance that for all ordinary practical percentages of reinforcement this factor (k) does not vary appreciably. It reduces to a value equal to .86 when the percentage of metal equals 1 per cent. For all lower percentages of metal its value is greater. It is, therefore, a very safe assumption to reduce our equation (7) to the following simple formula:—

$$\mathbf{R\,M = .86\,d\,A_s\,f} \qquad [8]$$

or for f = 16,000 pounds per sq. in.

$$\mathbf{R\,M = 13{,}760\,d\,A_s} \qquad [9]$$

For isolated beams *the percentage of reinforcement must not exceed 1 per cent for good rock concrete.* This does not apply to beams with double reinforcement and T beams, which will be treated later.

Double Reinforcement

In the case of isolated beams, when the percentage of tensile reinforcement exceeds 1 per cent., it is customary to provide compressive reinforcement to take care of this excess. The formulae for design of beams with double reinforcement, as ordinarily presented in text books, are so complicated and involved as to be of little practical value. The following method of determining the amount of compressive reinforcement is simple, direct and accurate.

Assume an extreme fibre stress of 750 pounds per sq. in. It will be necessary to place the compression steel at some distance, usually about 1/10 d, below the top of the beam, and the compression in the concrete at this plane will be, say 600 pounds per sq. in. As m = 15 the compression in the steel will be about 9,000 pounds per sq. in., or somewhat more than one-half the allowable stress of steel in tension. From this it is seen that for each square inch of reinforcement in excess of the allowed percentage in an isolated beam, there should be provided about 1.75 sq. in. of compressive reinforcement. For this purpose the most convenient steel possible is the center sheared Kahn Trussed Bar, the web members of which bind the bar securely into the beam and resist every tendency to buckle.

The neutral axis in the beam remains in the same location as in the simple beam, as the allowable unit stresses are the same, and the location of the neutral axis is determined by equation (2). The steel in compression being placed above the center of compression in the simple beam, the value of the factor (k) would tend to be increased, so that equation (9) can be used with perfect safety in this case. To summarize:—

In the case of isolated beams, in which the percentage of tensile reinforcement exceeds 1 per cent., provide compressive reinforcement equal in area to 1.75 times the excess area of tensile reinforcement. Then design by equation (9).

In no case should the total area of steel in compression exceed 75% of that in tension.

T Beams

When beams or girders are built so as to form part of a floor construction, the floor slab will act with and may be considered part of the same. In the construction of such a floor the concrete in the beam and slab must be placed continuously, so that the two will be perfectly united.

In the design of "T" beams there are four considerations, which govern the width of floor slab, that may be considered

as acting as the compressive flange of the beam. It is assumed in this discussion that sufficient steel has been provided in tension and that the beams are spaced sufficiently far apart, so that the spacing of beams will not determine the width of slab available. With these assumptions the four points in the design, each of which must be investigated and satisfied, are: (See figure 4.)

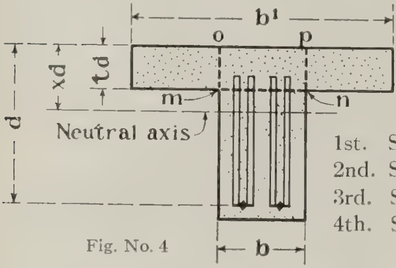


Fig. No. 4

1st. Shear along the plane *m n*.
2nd. Shear along the planes *m o* and *n p*.
3rd. Span of beam as affecting width of T.
4th. Strength in compression.

In regard to the first three of these considerations it is possible to make a complete analytic discussion, but the practical results of such an analysis are alone of value to the designer. The following conclusions are sanctioned by good authority and conservative practice.

1st. In order that the beam shall be safe in shear along the plane *m n* the width of slab computed as compression flange should not be greater than 5 times the width of the beam, i. e.,

b^1 must not exceed 5b.

2nd. b^1 must not exceed b + 10 td.

3rd. b^1 must not exceed 1-3 of the span of the beam.

4th. The width of flange necessary for compression is dependent on the ratio of the area of the tensile reinforcement in the bottom of the beam to the rectangular area of concrete *bd*.

The table given on page 61 shows the width of flange necessary in the terms of the width of beam, for various percentages of reinforcement and ratios of slab depths. This table is based on the following theoretical analysis:

Extreme fibre stress in concrete in compression, $c = 750$ pounds per sq. in.

Tensile stress in steel = 16,000 pounds per sq. in.

$m = 15$.

From equation 2, page 55 $\frac{c}{f} = \frac{x}{m\,(1\text{-}x)}$

Solving, $x = .413$.

The stress at lower edge of slab $= \frac{x\text{-}t}{x}\,c$

Ratio of Width of "T" to Width of Beam Required for Varying Percentages of Steel and Depths of Slab

Maximum Compression in Extreme Fibre = 750 Pounds per square inch.

Stress at Points Equidistant from Neutral Axis, same at all Points of T.

(t) Ratio of depth of Slab to depth of Steel	Percentage of Area of Steel, (A), to Rectangular Area of Concrete, (bd).											
	1¼	1½	1¾	2	2¼	2½	2¾	3	3¼	3½	3¾	4
.05	2.3	3.4	4.6									
.10	1.7	2.3	2.9	3.5	4.1							
.15	1.5	1.9	2.4	2.8	3.2	3.7	4.1					
.20	1.4	1.8	2.1	2.5	2.8	3.2	3.5	3.8	4.2			
.25	1.4	1.7	2.0	2.3	2.6	2.9	3.2	3.5	3.8	4.1		
.30	1.3	1.6	1.9	2.2	2.4	2.7	3.0	3.3	3.6	3.8	4.1	
.35	1.3	1.6	1.8	2.1	2.4	2.6	2.9	3.2	3.4	3.7	3.9	4.2
.40	1.3	1.5	1.8	2.0	2.3	2.6	2.8	3.1	3.4	3.6	3.9	4.1
.413	1.3	1.5	1.8	2.0	2.3	2.6	2.8	3.1	3.4	3.6	3.9	4.1

NOTE:—For all ratios greater than .413, $\frac{b'}{b}$ has same value as given for .413.

NOTE:—Table gives values of $\frac{b'}{b}$

See Figure 4, page 60.

Total compressive stress =

$$\frac{1}{2}\,c\,b\,x\,d + \frac{1}{2}\,(b'-b)\,\frac{(2\,x-t)}{x}\,ctd.$$

Total tensile stress $= 16{,}000\ p\ b\ d$,

Equating and solving for $\frac{b^1}{b}$

$$\frac{b^1}{b} = 1 + \frac{32{,}000\ p-cx}{\frac{2x-t}{x}\ c\ t}$$

Substituting values of *c* and *x* above.

$$\frac{b^1}{b} = 1 + \frac{32{,}000\ p-310}{(.826-t)\ 1816\ t},$$

When the lower edge of the slab falls below the neutral axis, the analysis of the beam is the same as for a simple beam of width b^1 and depth *d*.

An inspection of the table will show that, under ordinary conditions of design, the slab will supply sufficient compressive reinforcement. In case it does not, steel must be provided in compression, as indicated under design for "Double Reinforcement," page 59.

As the center of compression in the T beam will be relatively higher, or equally as high, as in the simple beam, the equation for moment of resistance for a simple beam may be used safely in the design of T beams, i. e.,

R M $= .86\ f\ A_s d = 13{,}760\ A_s d.$

The designer will readily see that shear plays an important part in beam design and that shear reinforcement must be provided. This shear reinforcement should be rigidly connected to the main tension member, so that its stress may be transferred directly to this member. The Kahn Trussed Bar, with its rigidly connected diagonals, accomplishes this result in a simple, adequate and economical manner.

Design of Beam Limited by Compression in Concrete

The theory of design for beams, presented up to this point, has been based on a safe working stress of 16,000 pounds per sq. in. in the steel in tension and an extreme fibre stress of 750 pounds per sq. in. in the concrete in compression. It has been shown that where the percentage of tensile reinforcement is less than 1 per cent. the compressive stress will be less than 750 pounds and therefore need not be considered.

In the previous discussion, where more than 1 per cent. of reinforcement is required, the extreme fibre stress is limited to 750 pounds, either by the use of compressive reinforcement or by making the beams T section.

On rare occasions, in the case of isolated beams and floor slabs, the percentage exceeds 1 per cent. and it is not found practical to use either of the two alternatives just mentioned. Under such circumstances the moment of resistance of the beam is limited by the extreme fibre stress (750 pounds) in the concrete, irrespective of the stress in the tensile reinforcement. The moment of resistance is then determined by equation (6) page 55, i. e.:

$$\mathbf{R\,M} = \left(1 - \frac{x}{3}\right)\frac{cxbd^2}{2} = \left(1 - \frac{x}{3}\right) \frac{cx}{2} \quad \frac{A_s\,d}{p}$$

The table given on page 64 gives the computed value of the moments of resistance and position of neutral axis for various percentages of reinforcement, based on this formula.

The designer should remember that it is usually decidedly uneconomical of material to design so as not to fully develop the strength of the steel reinforcement. Such a design should be avoided wherever possible.

Section of Shipping Yards at our Youngstown Shops.

Moments of Resistance of Beams

When the design is limited by the compression of the concrete and the full tensile strength of steel is not developed.

Percentage of Reinforcement	Position of Neutral Axis Values of X.	Moment of Resistance	
		Depending on Area of Steel	Depending on Area of Concrete
1.1%	0.4327	12620 dAs	139 bd^2
1.2%	0.4464	11880 dAs	142 bd^2
1.3%	0.4592	11220 dAs	146 bd^2
1.4%	0.4712	10640 dAs	149 bd^2
1.5%	0.4825	10120 dAs	152 bd^2
1.6%	0.4932	9660 dAs	155 bd^2
1.7%	0.5033	9240 dAs	157 bd^2
1.8%	0.5129	8860 dAs	159 bd^2
1.9%	0.5220	8510 dAs	162 bd^2
2.0%	0.5307	8190 dAs	164 bd^2
2.1%	0.5389	7890 dAs	166 bd^2
2.2%	0.5468	7620 dAs	168 bd^2
2.3%	0.5545	7370 dAs	170 bd^2
2.4%	0.5617	7130 dAs	171 bd^2
2.5%	0.5687	6910 dAs	173 bd^2
2.6%	0.5755	6710 dAs	174 bd^2
2.7%	0.5819	6510 dAs	176 bd^2
2.8%	0.5882	6330 dAs	177 bd^2
2.9%	0.5942	6160 dAs	179 bd^2
3.0%	0.6000	6000 dAs	180 bd^2

Columns 3 and 4 give equal values for moment of resistance. Note in column 3 the decreasing tensile stress in the steel and the consequent loss in economy.

Where percentage is 1% or less, R M = 13760 d As.

Shear in Reinforced Concrete Beams

The vertical shear at any section of a beam is the reaction at one end minus that part of the load lying between the end and the section. It is shown in mechanics that at any point in a beam the vertical unit shear is equal to the horizontal unit shear.

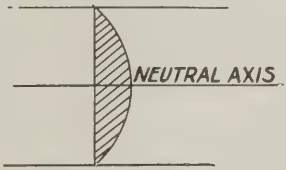


Fig. No. 5.

The distribution of the shearing stresses on the vertical section of a beam of homogeneous material is shown in figure No. 5. It will be noted that the shear varies as the ordinates to a parabola with the maximum shear at the neutral axis and equal in magnitude to 3/2 the mean unit shear.

The distribution of shearing stresses on a vertical section of a reinforced concrete beam is shown by figure No. 6. The

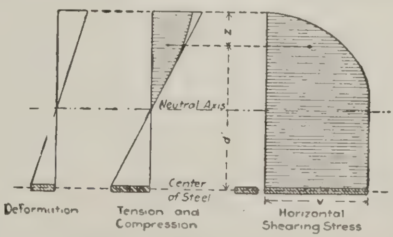


Fig. No. 6.—Distribution of Horizontal and Vertical Shear.

shear distribution in the beam of homogeneous material is similar to that of the reinforced concrete beam, except for that portion of the curve below the neutral axis. As no tension is considered as acting in the concrete there will be no change in the intensity of the horizontal and vertical shearing stresses below the neutral axis, whereas in the beam of homogeneous material the intensities vary as shown by the figure.

In the flexure of a simple beam the upper fibres are compressed and the lower fibres are stretched in amounts proportionate to the distance of these fibres from the neutral axis.

From the above it is evident that at every point of a beam there exists a horizontal and vertical shear and also a longitudinal tension or compression.

By combining the bending moment stresses with the shearing stresses at the various points in a beam lines of so-called principal stress are drawn as shown in figure No. 7. At

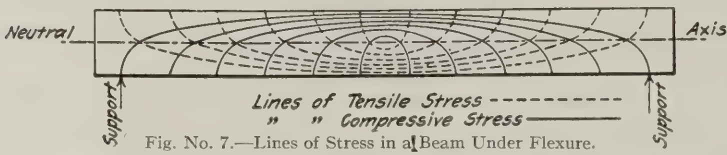


Fig. No. 7.—Lines of Stress in a Beam Under Flexure.

the center of the span the tensile and compressive stresses are horizontal; but as the ends are approached the lines of tensile stress incline upwards and those of compressive stress incline downwards, so that at all points away from the center of the span these stresses have both horizontal and vertical components. The horizontal components reach a maximum at the center of the span and the vertical at the ends.

It will be noticed from the above figure that the lines of tension stresses incline up and away from the center at an average angle of 45 degrees, while the lines of compressive stresses cross these tension lines at right angles and incline down toward the ends of the span.

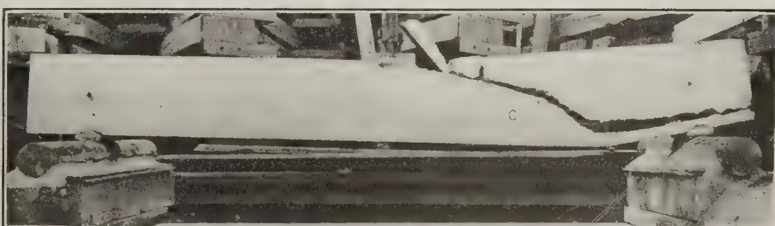
If the fundamental idea of reinforcing the concrete for tension is carried out, it is evident that steel members traversing the lines of principal tension stresses must be included in the design. If these members are to carry stresses they must be connected to some part of the structure that is capable of receiving it. The main tension member in the bottom of the beam provides such a connection, and it is only natural that this main tension member be utilized for this purpose. The web members of the Kahn Trussed Bar are rigidly connected to the main bar so that there can be no slipping at the connection. These web members extend up into the compressed area of the concrete and the upper portion is gripped and held in place not only by the adhesion to the concrete, but also by the thrust in the concrete acting at right angles to the axis of the web member. A complete truss is thus formed with tension flange of steel, compression flange of concrete and steel tension diagonals rigidly held at either end.

Merriman in his text book on mechanics gives an expression for maximum diagonal tension as $t = \frac{1}{2}s + \sqrt{\frac{1}{4}s^2 + v^2}$, where "t" is the diagonal tensile unit-stress, "s" is the horizontal tensile unit-stress existing in the concrete, and "v" is the horizontal or vertical shearing unit-stress. The direction

of this maximum diagonal tension makes an angle with the horizontal equal to one-half the angle whose cotangent is $\frac{1}{2}\frac{s}{v}$.

If there is no tension in the concrete, this reduces to $t=v$, and the maximum diagonal tension makes an angle of 45 degrees with the horizontal, and is equal in intensity to the vertical shearing stress.

When the diagonal tensile stresses developed becomes as great as the tensile strength of the concrete, the beam will fail by diagonal tension, provided there is no metallic web reinforcement. The accompanying cut gives the typical form which this failure takes. As the value of the maximum diagonal tensile stress developed in a beam is, by equation ($t=\frac{1}{2}s+\sqrt{\frac{1}{4}s^2+v^2}$), dependent upon the horizontal tensile stress developed at the same point, it is difficult to compute its actual amount. The best method seems to be to compute the horizontal and vertical shearing unit-stress, and make all comparisons on the basis of this value.



Bessemer Steel, High Carbon, Deformed Bar.
See report of Boston Transit Commission, June 30, '04.
Fracture showing method of failure, due to shear, which occurs almost invariably when horizontal reinforcement alone is used. Steel stretched only to its elastic limit.

Beam Reinforced with Kahn Trussed Bar.
See Eng. News, vol. L. p. 349. See Eng. Record, vol. 48, p. 465.
Note that when tested to destruction the steel pulled in two.
Ultimate strength of steel developed.

Pieces Under Direct Compression

Unhooped Columns

In combining steel and concrete to resist compression, theoretically the load is borne by the two materials in a ratio determined by their relative modulii of elasticity. With this ratio 1 to 15 and a safe stress in the concrete of 500 pounds the steel will carry 7500 pounds per square inch. The natural disposition of this reinforcing steel is near the periphery of the column. In this position the reinforcing steel will take up whatever secondary stresses may occur caused by the possible eccentric application of the applied loads, or by unequal settlement of the footings.

The longitudinal reinforcing rods consisting of Rib Bars should be stayed at intervals of 12 inches with No. 3 (¼ inch diameter) wire extending around the column.

Columns loaded unsymmetrically, and especially corner columns, should be figured with lower unit stresses. On account of the monolithic nature of construction it is somewhat difficult to say just what eccentricity a certain loading gives. In outside columns there is, undoubtedly, an eccentric load, and this should be provided for in the design by allowing a lower fiber stress.

Least width of column should not exceed 1/15 of its unsupported length.

See page 116 for safe loads on square columns.

Hooped Columns

Hooped columns, as developed by M. Considere, consist of a number of longitudinal bars arranged on the circumference of a circle with a steel band wrapped around these bars in spiral turns, varying from 1 to 3 inches apart, depending upon the design. This form of reinforcement increases the compressive strength of the concrete greatly and enables it to withstand much greater deformation and unit stresses. Considere shows that plain concrete under compressive stresses tends to fail by splitting longitudinally and bulging laterally. By enclosing it in a spiral wrapping of sufficiently small pitch the lateral bulging is resisted and the concrete will not only stand higher stresses without failure, but will also undergo much greater shortening. For a theoretical discussion of this subject the reader is referred to "Experimental Researches on

Reinforced Concrete," by Armand Considere, published by the McGraw Publishing Co. under date of 1906.

The table on page 117 is based upon the theory as developed by Considere. This theory is outlined by the following formula:

$$P = A_c F_c + m F_c (A_s + 2.4 A_s^1).$$

Where P = safe load on column.

F_c = load per sq. in. on net section of core.

A_c = net area of concrete inside of hooping.

$$m = \frac{\text{modulus of elasticity of steel.}}{\text{modulus of elasticity of concrete.}}$$

A_s = Total area of cross section of vertical rods.

A_s^1 = area of cross section of imaginary vertical rods having same quantity of steel as the hooping.

The following values are used in figuring the tables:

F_c = 750 lbs.

m = 15.

Least width of column should not exceed 1/15 of its unsupported length.

Shop-made Column Hooping (See page 24).

Bending Moments

Reinforced concrete differs from the ordinary types of building construction in that it is built continuous and monolithic. For this reason, girders and slabs must be designed to a large extent as continuous structures and provision must be made to take care of the negative bending moments occurring at the supports. This is done in practice by inverting Kahn Trussed Bars in the top of the concrete over the support.

It will often be found that in order to make the construction perfectly continuous in accordance with the accepted theory of continuous beams, the negative bending moment over the support will exceed the positive bending moment at the center of the span.

Theoretically, for beams uniformly loaded, the proper requirements in regard to strength will be satisfied when the bending moment at the center of the span plus one-half the sum of the negative bending moments at the supports is equal to $\frac{Wl}{8}$.

W = total uniform load on beam; l = span of beam.

The steel and concrete must be properly designed to take care of the bending moments at all points.

It is often found impractical, however, to design beams for perfect continuity, but authorities are agreed that a certain amount of continuity may be figured on.

The bending moments adapted in the various tables of this publication are purposely made conservative to prevent misuse and do not represent the minimum standards of good practice.

Rectangular Floor Slabs

When a slab is built in, or freely supported on four sides, the loads are carried in two directions to the supports and the slab is reinforced accordingly. Let,

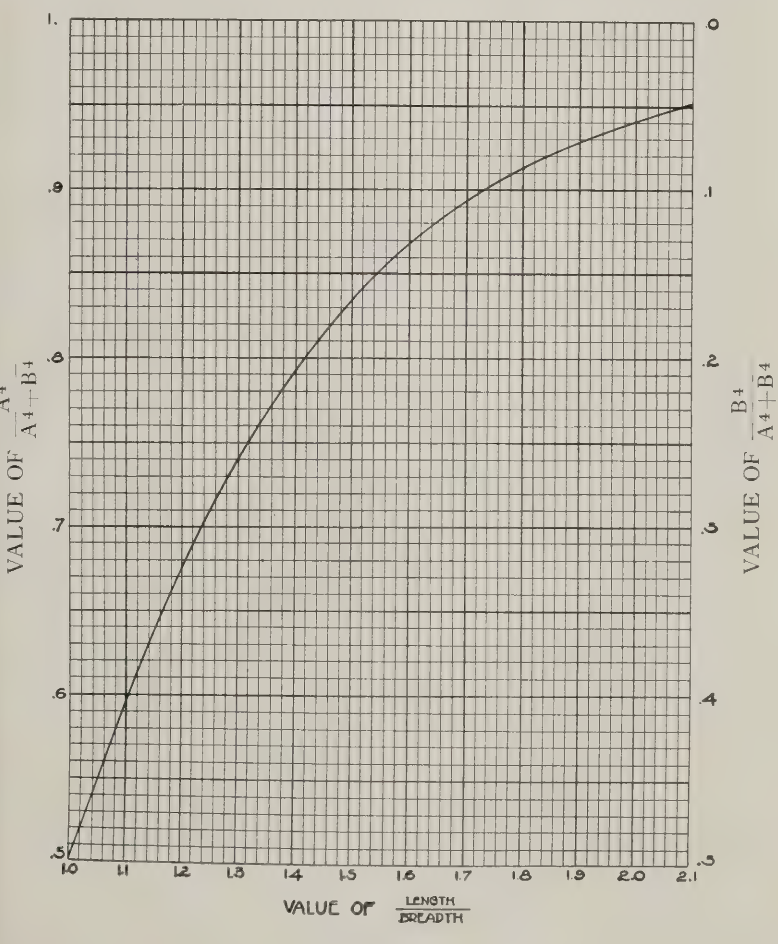
A = longer span of panel.

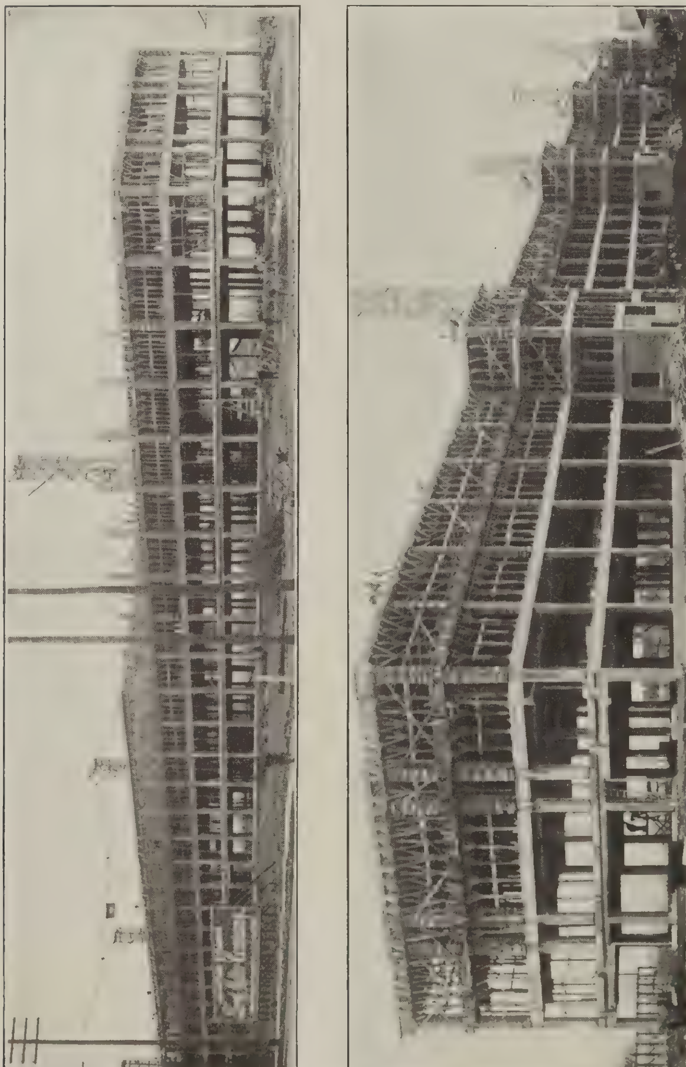
B = shorter span of panel.

M = Bending moment for slab supported on two sides only.

Then the bending moment for longer span $=\frac{B^4}{A^4+B^4}M$ and the bending moment for shorter span $=\frac{A^4}{A^4+B^4}M$.

The greatest bending moment will always be that for the shorter span. The curve shown below indicates the value of these two factors for varying proportions of length and breadth of panel.



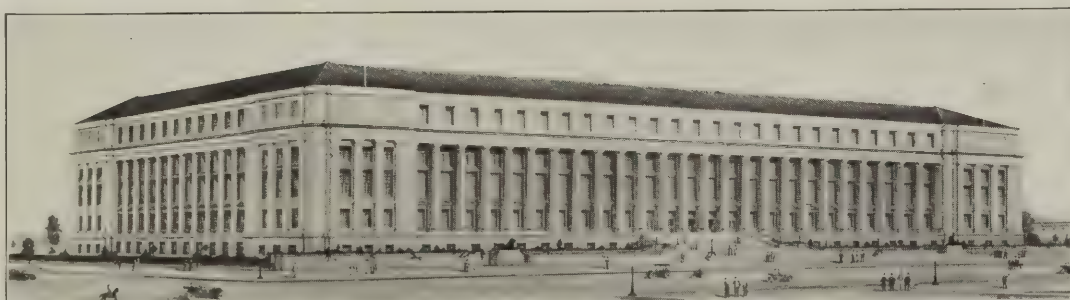


Construction of 865-Foot Building at Ford Motor Co., Detroit, showing various stages in the erection of a Kahn System Building.

Dodge Bros. Plant, Detroit, Mich.
Administration Building, Factory, Power House, etc., Kahn System Reinforced Concrete.
Albert Kahn, Architect. Ernst Wilby, Associate.

U. S. Government Department of Agriculture, Laboratory Buildings.

Kahn System Reinforced Concrete. Rankin, Kellogg & Crane, Architects.



Bureau of Printing and Engraving, Washington, D. C.

Built Kahn System Reinforced Concrete—Windows of United Steel Sash.

J. Henry Miller Co., Inc., Builders. James Knox Taylor, Supervising Architect.

Marlborough-Blenheim Hotel, Atlantic City, N. J.

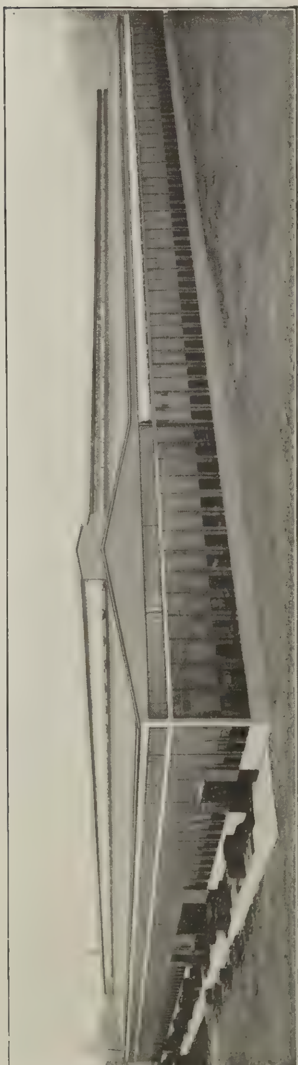
Built throughout of Kahn System Reinforced Concrete.

Price & McLanahan, Architects.

Lake Superior Iron & Chemical Co., Manistique, Mich.
Hy-Rib Concrete Sidings and Roof.

Merchants' Storage Warehouse, Des Moines, Ia.
Kahn System Reinforced Concrete. Wetherell & Gage, Architects.

"The Daylight Store" of Owen & Co., Detroit.
Kahn System Reinforced Concrete. Albert Kahn, Architect, Ernst Wilby, Associate.

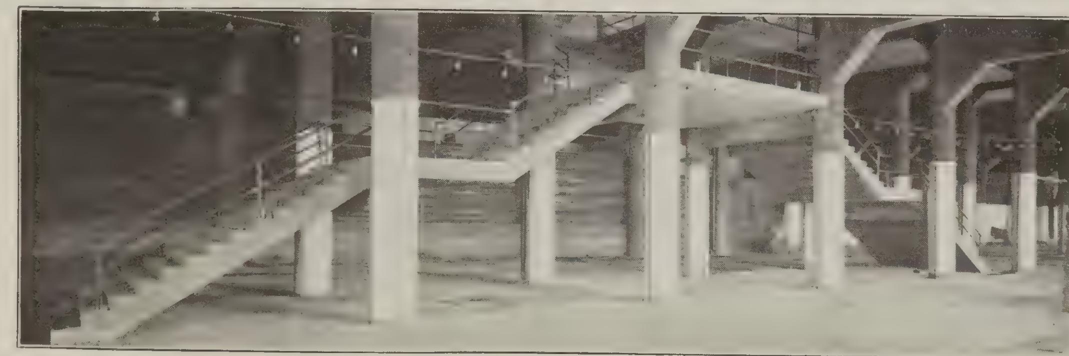


Modern, Daylight, One-Story Factory at our Youngstown Plant.
United Steel Sash for Windows and Monitors—Hy-Rib Concrete Sidings and Roofs.

Saw Tooth Roofs, Ford Motor Co., Detroit.
Hy-Rib Concrete Roofs and Sidings.

Stadium, Syracuse University, Syracuse, N. Y.

Built Kahn System Reinforced Concrete. Revels & Hallenbeck, Architects.



Stairway, Grand Stand, Minnesota State Fair, St. Paul, Minn.

Built Kahn System Reinforced Concrete. Reed & Stem, Architects.

Kahn System Flat Ceilings, Dodge Bros., Detroit.
No projecting beams or brackets. United Steel Sash for Windows.

Flat Ceilings (Kahn System), Continental Motor Mfg. Co., Detroit.
Albert Kahn, Architect. Ernst Wilby, Associate.

Flat Ceilings, Burroughs Adding Machine Co., Detroit.
United Steel Sash for Windows.

Kahn System Flat Ceilings, American Electrical Heater Co., Detroit, Mich.
Also United Steel Sash.
Albert Kahn, Architect. Ernst Wilby, Associate.

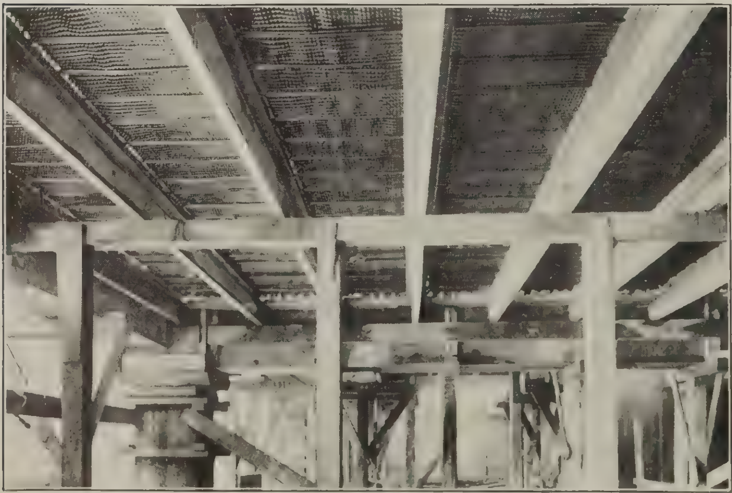
Storehouse, Portland Railway, Light & Power Co., Portland, Ore.
Kahn System Flat Ceilings with Brackets; also United Steel Sash.

Standard Furniture Co., Herkimer, N. Y.
Kahn System Flat Ceilings with Brackets; also United Steel Sash.

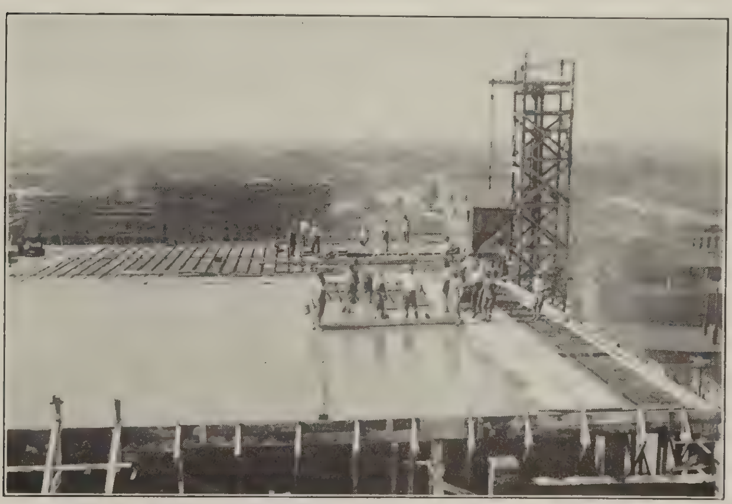
Floredome Construction, Mt. Tabor School, Portland, Ore.
Thomas Jones, Architect.

Flat Ceilings of Floredome Construction,
Packard Service Building, Los Angeles, Cal.
Parkinson & Bergstrom, Architects. F. O. Engstrum Co., Contractors.

Floretyle Construction, Alta Planing Mill, Los Angeles, Cal.



Simple Centering for Floretyle Construction.
Woodward-Clark Building, Portland, Ore.
Doyle, Patterson & Beach, Architects.



Floretyle Construction showing work partly concreted and underside before plastering, Fidelity Building, Cedar Rapids, Ia.

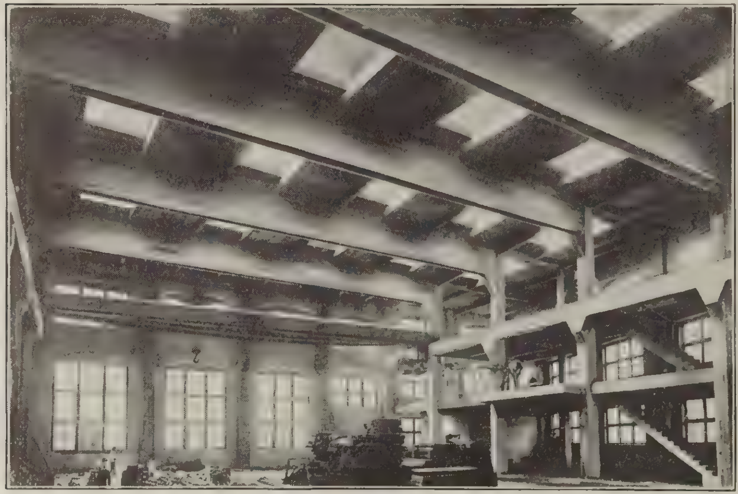
Kahn System Cantilever Slabs, D. Sommers & Co. Building, Indianapolis.
Robush & Hunter, Architects.

Kahn System Cantilever Slabs, Flanders Building, Detroit, Mich.
Albert Kahn, Architect. Ernst Wilby, Associate.

Reinforced Hollow Tile Floors—32 Feet Spans for Girders and Beams.
Packard Motor Car Co., Detroit.

Albert Kahn, Architect. Ernst Wilby, Associate.

Kahn System Solid Concrete Slabs and Intermediate Beams.
White Garage, San Francisco.
McDonald & Applegarth, Architects



Kahn System Girders with spans of 74 feet 8 inches.
Foundry of Williams-White Co., Moline, Ill.

55-foot Spans, built Kahn System Reinforced Concrete.
Plant of Geo. N. Pierce Co., Buffalo, N. Y.
Lockwood, Greene & Co., Architects.

Bulk Soda Storage Bin, Solvay Process Co., Delray, Mich.
Kahn System Reinforced Concrete
C. E. Herbert, Engineer

Coal Bins, Diamond Crystal Salt Co., St. Clair, Mich.
Kahn System Reinforced Concrete
Weil & Shaw, Engineers

Explanation of Tables for Floor Slabs

The tables for Floor Slabs, pages 91 to 106, are computed for Bending Moments equal to $1/10\ wl^2$. To take care of this partial continuity, reinforcement must be provided in the top of the slab over the supports, equal in area to ¼ of the area of the steel in center of the span. Greater continuity can be figured on by using a smaller Bending Moment at the center and increasing the top reinforcement over the supports to take care of the increased negative Bending Moment. For slabs which merely rest on supports, the Bending Moment should be taken at $\frac{1}{8}\ wl^2$. In all such cases, where the Bending Moment is $\frac{wl^2}{K}$ (K, having any value) the safe live loads carried by the slab will then equal:

$$\frac{K}{10} \text{ x loads in table} + \left(\frac{K}{10} - 1\right) \text{ x weight of slab per sq. ft.}$$

In this way the tables may be used with any value of Bending Moment.

The loadings given in tables for slabs are safe live loads per square foot. The full dead weight of the slab has been deducted in every case in preparing the tables. All slabs are computed for stress in steel of 16,000 pounds per square inch.

All floor slabs should have a thickness equal to at least 1/30 of the clear span.

The tables given indicate only general types of design. Other arrangements of reinforcement, hollow tile, Floretyles, etc., will suggest themselves and can be readily computed. Our engineers will be glad to suggest the most economical construction in each individual case.

Note that we have not given any tables for flat ceiling designs of solid concrete. In this type of construction each individual building must be analyzed separately, so that general tables are unsatisfactory. Our Engineers have had a wide experience in flat ceiling designs of all types, including solid concrete, terra cotta tile, Floretyle, etc., and will gladly make specific suggestions for any definite construction.

Spacing of Bars in Inches for Various Safe Live Loads Per Square Foot

4″ Slab ½″x1½″ Kahn Trussed Bars, Area = 0.41 sq. in.

Load in Pounds	Span in Feet 6	7	8	9	10
50					18.7
75				18.3	14.9
100			19.4	15.3	12.4
125			16.6	13.1	10.6
150		18.9	14.4	11.4	
175		16.8	12.8	10.1	
200	20.5	15.1	11.5		
250	17.1	12.5			
300	14.6	10.7			
350	12.8	9.4			
400	11.4	8.3			

$$B.\ M. = \frac{w\ l^2}{10}$$

$R.\ M. = 0.86 \times 3.25 \times 0.41 \times 16000$

Maximum Spacing = 16″

Minimum Spacing = 12.6″

4½″ Slab ½″x1½″ Kahn Trussed Bars, Area = 0.41 sq. in.

Load in Pounds	Span in Feet 6	7	8	9	10	11
50						16.8
75					16.4	13.6
100				17.0	13.7	11.3
125			18.5	14.6	11.8	9.8
150			16.2	12.8	10.4	8.6
175		18.9	14.4	11.4	9.2	
200		17.0	13.0	10.3	8.3	
250	19.4	14.2	10.9	8.6		
300	16.6	12.2	9.3			
350	14.5	10.7	8.2			
400	12.9	9.5				
500	10.6					

$$B.\ M. = \frac{w\ l^2}{10}$$

$R.\ M. = 0.86 \times 3.75 \times 0.41 \times 16000$

Maximum Spacing = 16″

Minimum Spacing = 10.9″

See explanation of tables page 90.

Spacing of Bars in Inches for Various Safe Live Loads Per Square Foot

5″ Slab ½″x1½″ Kahn Trussed Bars, Area = 0.41 sq. in.

Load in Pounds	SPAN IN FEET 6	7	8	9	10	11	12
50						18.0	15.1
75					17.7	14.6	12.3
100				18.5	15.0	12.4	10.4
125				16.0	13.0	10.7	9.0
150			17.8	14.1	11.4	9.4	
175		20.8	15.9	12 6	10.2	8.4	
200		18.8	14.4	11.4	9.2		
250	21.5	15.8	12.1	9.6			
300	18.5	13.6	10.4	8.2			
350	16.2	11.9	9.1				
400	14.5	10.6	8.2				
500	11.9	8.7					
600	10.1	7.4					

$$B.\ M. = \frac{w\,l^2}{10}$$

$$R.\ M. = 0.86 \times 4.25 \times 0.41 \times 16000$$

Maximum Spacing = 16″
Minimum Spacing = 9.7″

6″ Slab ½″x1½″ Kahn Trussed Bars, Area = 0.41 sq. in.

Load in Pounds	SPAN IN FEET 8	7	10	11	12	13	14	15
50					16.8	14.4	12.4	10.8
75				16.7	14.0	11.9	10.3	8.9
100			17.2	14.2	11.9	10.2	8.8	7.6
125		18.6	15.1	12.5	10.4	8.9	7.7	
150		16.5	13.4	11.0	9.3	7.9		
175	18.7	14.8	12.0	9.9	8.3	7.2		
200	17.0	13.4	10.9	9.0	7.6			
250	14.4	11.4	9.2	7.6				
300	12.5	9.8	8.0					
350	10.9	8.7	7.0					
400	9.8	7.7						
500	8.1	6.4						

$$B.\ M. = \frac{w\,l^2}{10}$$

$$R.\ M. = 0.86 \times 5.25 \times 0.41 \times 16000$$

Maximum Spacing = 16″
Minimum Spacing = 7.8″

See explanation of tables p. 90.

Spacing of Bars in Inches for Various Safe Live Loads Per Square Foot

7″ Slab ¾″x2$\frac{3}{16}$″ Kahn Trussed Bars, Area = 0.79 sq. in.

Load in Pounds	SPAN IN FEET									
	8	9	10	11	12	13	14	15	16	17
50										16.8
75									16.0	14.2
100							18.1	15.8	13.9	12.2
125						18.4	15.9	13.9	12.2	
150						16.5	14.2	12.4		
175					17.5	14.8	12.9			
200				19.0	15.9	13.6	11.7			
250			19.5	16.1	13.6	11.6				
300			17.0	14.0	11.8					
350		18.6	15.0	12.4						
400		16.6	13.5	11.1						
500	17.4	13.8	11.2							
600	14.9	11.8								
800	11.5									

$$B.\ M. = \frac{w\,l^2}{10}$$

$R.\ M. = 0.86 \times 6 \times 0.79 \times 16000$

Maximum Spacing = 16″

Minimum Spacing 13.2″

See explanation of tables p. 90.

Spacing of Bars in Inches for Various Safe Live Loads Per Square Foot

8″ Slab ¾″x2$\frac{3}{16}$″ Kahn Trussed Bars. Area = 0.79 sq. in.

Load in Pounds	SPAN IN FEET 6	7	8	9	10	11	12	13	14
250						18.2	15.3	13.0	11.2
300					19.2	15.9	13.4	11.4	9.8
350					17.1	14.1	11.9	10.1	
400				19.0	15.3	12.7	10.6		
500			19.9	15.8	12.8	10.6			
600			17.1	13.5	10.9				
800		17.3	13.3	10.5					
1000		14.2	10.9						
1200	16.3	12.0	9.2						
1400	14.1	10.4							

Load in Pounds	SPAN IN FEET 12	13	14	15	16	17	18	19	20
50						18.0	16.1	14.4	13.0
75					17.4	15.4	13.7	12.3	11.1
100				17.2	15.2	13.4	12.0	10.7	
125			17.6	15.3	13.4	11.9	10.6		
150		18.3	15.8	13.8	12.1	10.7			
175		16.6	14.3	12.5	11.0				
200	17.9	15.2	13.1	11.4	10.0				
250	15.3	13.0	11.2						

Maximum Spacing = 16″ $\qquad B.M. = \frac{wl^2}{10}$

Minimum Spacing = 11.2″ $\qquad R.M. = 0.86 \times 7 \times 0.79 \times 16000$

See explanation of tables page 90

Spacing of Bars in Inches for Various Safe Live Loads Per Square Foot

10″ Slab $\frac{3}{4}$″x2$\frac{3}{16}$″ Kahn Trussed Bars. Area = 0.79 sq. in.

Load in Pounds	SPAN IN FEET 6	7	8	9	10	11	12	13	14	15
125										17.7
150										16.1
175									16.9	14.8
200								18.1	15.6	13.6
250							18.4	15.6	13.5	11.8
300							16.2	13.8	11.9	10.4
350						17.2	14.4	12.3	10.6	9.3
400					18.8	15.5	13.1	11.1	9.6	8.4
500				19.5	15.8	13.0	10.9	9.3	8.1	
600				16.8	13.6	11.2	9.4	8.0		
800			16.6	13.1	10.6	8.8	7.4			
1000		17.8	13.7	10.8	8.7					
1200	20.6	15.1	11.6	9.2						
1400	17.9	13.1	10.1	7.9						

Load in Ponnds	SPAN IN FEET 16	17	18	19	20	21	22	23	24	25
50			17.7	15.9	14.4	13.1	11.9	10.9	10.0	9.2
75		17.3	15.4	13.9	12.5	11.4	10.3	9.5	8.7	8.0
100	17.4	15.4	13.7	12.3	11.1	10.1	9.2	8.4		
125	15.6	13.8	12.3	11.1	10.0	9.1	8.2			
150	14.2	12.5	11.2	10.1	9.1	8.2				
175	13.0	11.4	10.2	9.2	8.3					
200	11.9	10.6	9.4	8.5						
250	10.3	9.1	8.2							
300	9.1	8.1								
350	8.1									

Maximum Spacing = 16″ $\quad B.M. = \frac{wl^2}{10}$

Minimum Spacing = 9″ $\quad R.M. = 0.86 \times 9 \times 0.79 \times 16000$

See explanation of tables page 90.

Spacing of Bars in Inches for Various Safe Live Loads Per Square Foot

12″ Slab ¾″x2$\frac{3}{16}$″ Kahn Trussed Bars. Area = 0.79 sq.in.

Load in Pounds	SPAN IN FEET										
	8	9	10	11	12	13	14	15	16	17	18
75											16.8
100										16.9	15.1
125									17.3	15.4	13.7
150									15.9	14.0	12.5
175								16.6	14.6	12.9	11.5
200							17.7	15.4	13.6	12.0	10.7
250						17.9	15.5	13.5	11.8	10.5	9.3
300						15.9	13.7	11.9	10.5	9.3	8.3
350					16.8	14.3	12.3	10.7	9.5	8.4	7.4
400				18.2	15.2	13.0	11.2	9.7	8.6	7.6	6.8
500			18.6	15.3	12.9	11.0	9.5	8.2	7.2	6.4	
600		19.8	16.0	13.2	11.1	9.5	8.2	7.1	6.3		
800		15.6	12.6	10.4	8.8	7.5	6.5	5.6			
1000	16.3	12.9	10.4	8.6	7.2	6.2					
1200	14.0	11.0	8.9	7.3	6.2						
1400	12.1	9.5	7.7	6.4							

Load in Pounds	SPAN IN FEET										
	19	20	21	22	23	24	25	26	27	28	29
50	17.1	15.4	14.0	12.7	11.6	10.7	9.8	9.1	8.4	7.9	7.3
75	15.1	13.6	12.4	11.3	10.3	9.5	8.7	8.1	7.5	7.0	6.5
100	13.6	12.3	11.1	10.1	9.3	8.5	7.8	7.2	6.7		
125	12.3	11.1	10.1	9.2	8.4	7.7	7.1	6.6			
150	11.2	10.2	9.2	8.4	7.7	7.1	6.5				
175	10.4	9.4	8.5	7.7	7.1	6.5					
200	9.6	8.6	7.9	7.2	6.5						
250	8.4	7.6	6.9	6.3							
300	7.5	6.7									

$\text{B. M.} = \frac{wl^2}{10}$

Maximum Spacing = 16″
Minimum Spacing = 7.2″
R. M. = 0.86 x 11 x 0.79 x 16000

See explanation of tables page 90.

Safe Live Loads in Pounds per Square Foot for Slabs Reinforced with Rib Metal

3-Inch Slab

Span in Feet	MESH 4	5	6	7	8
3	824	652	537	455	394
4	447	351	286	240	206
5	273	212	170	140	119
6	179	136	107	87	71
7	122	90	69	54	43
8	85	61	45	33	25

3½-Inch Slab

Span in Feet	MESH 3	4	5	6	7	8
4	732	539	412	345	290	248
5	454	330	255	206	170	144
6	309	222	169	134	109	90
7	211	148	110	84	66	53
8	152	104	74	55	41	31
9	111	73	50	34	23	

4-Inch Slab

Span in Feet	MESH 3	4	5	6	7	8
4	856	630	494	404	339	281
5	531	386	299	241	200	169
6	354	253	193	153	124	103
7	248	174	130	98	79	63
8	179	122	88	65	49	37
9	131	86	59	41	28	19
10	97	61	39	24		
11	70	41	24			

4½-Inch Slab

Span in Feet	MESH 3	4	5	6	7	8
4	978	720	566	462	398	333
5	606	441	342	276	229	194
6	406	291	222	176	143	118
7	284	199	148	114	91	73
8	204	140	101	75	57	43
9	150	99	68	48	33	23
10	111	70	45	29		
11	83	49	28			
12	61	32				

5-Inch Slab

Span in Feet	MESH 2	3	4	5	6	7	8
4	1682	1101	811	637	521	438	376
5	1056	684	498	386	312	258	219
6	714	456	327	250	198	162	134
7	510	320	225	168	130	103	83
8	376	231	158	114	85	65	49
9	285	170	113	88	55	39	26
10	219	126	80	52	33	20	
11	171	94	56	32	17		
12	134	69	37	18			
13	105	50	22				

6-Inch Slab

Span in Feet	MESH 2	3	4	5	6	7	8
4	2057	1347	988	780	638	538	458
5	1292	837	610	474	383	318	269
6	877	561	403	308	244	199	165
7	625	393	277	207	160	126	102
8	460	283	194	141	105	80	61
9	349	209	139	96	68	48	34
10	269	155	99	64	42	25	
11	210	116	69	41	22		
12	165	86	47	23			
13	130	63	29				
14	102	44					
15	80	39					

B. M. = $1/10\ w\ l^2$. Stress in steel = 16,000 pounds per square inch.
See explanation of tables page 90.

Safe Live Loads in Pounds per Square Foot for Slabs Reinforced with 4-Rib Hy-Rib

(See also Table Below.)

Thickness of Slabs above base of sheathing	Gauge No. 4-Rib Hy-Rib	Moment of resistance per foot of width	SPAN IN FEET								
			3	4	5	6	7	8	9	10	11
1 " thick slab	28	965	76	38							
	26	1155	93	48	27						
	24	1540	128	68	40						
1½" thick slab	28	1838	152	77	43	25					
	26	2205	186	96	56	33					
	24	2940	254	134	80	50					
2 " thick slab	28	2675	222	115	65	38					
	26	3210	271	143	83	50	30				
	24	4280	370	198	118	74	48				
2½" thick slab	28	4125	350	184	106	65	40	24			
	26	4950	426	227	134	84	54	35			
	24	6600	578	312	188	122	82	56			
3 " thick slab	28	6150	533	284	168	106	68	44	27		
	26	7380	647	248	209	135	89	60	39	24	
	24	9840	874	476	290	192	130	92	64	44	
3½" thick slab	28	7275	633	338	199	127	82	53	33	18	
	26	8730	768	414	248	161	107	72	48	30	
	24	11640	1038	566	344	228	156	110	78	54	38

Maximum Spans for 4-Rib Hy-Rib as Centering

To support various thicknesses of wet concrete. For greater spans use temporary supports

Gauge of 4-Rib Hy-Rib	THICKNESS OF SLAB						
	1″	1½″	2″	2½″	3″	3½″	4″
No. 24	5′ 0″	4′ 0″	3′ 6″	3′ 2″	2′ 10″	2′ 8″	2′ 6″
No. 26	4′ 3″	3′ 6″	3′ 0″	2′ 9″	2′ 6″	2′ 4″	2′ 2″
No. 28	3′ 11″	3′ 2″	2′ 9″	2′ 6″	2′ 3″	2′ 1″	1′ 11″

See page 26 for description of 4-Rib Hy-Rib.

Safe Live Loads in Pounds per Square Foot for Slabs Reinforced with Deep-Rib Hy-Rib

(See also Table below)

Thickness of Slabs above base of sheathing	Gauge No. Deep-Rib Hy-Rib	Moment of resistance per foot of width	SPAN IN FEET								
			4	5	6	7	8	9	10	11	12
2 " thick slab	26	3680	168	99	61	39					
	24	4100	190	112	71	46					
	22	4520	211	127	81	53					
2½" thick slab	26	4560	207	122	76	48	29				
	24	6090	287	173	111	73	49				
	22	7080	339	206	134	90	62				
3 " thick slab	26	5790	266	157	98	62	39				
	24	7710	366	221	143	95	64	43			
	22	9630	466	285	188	128	89	63			
3½" thick slab	26	7000	323	191	120	77	49	30			
	24	9330	444	269	174	117	80	54	36		
	22	11670	564	347	228	157	111	78	55		
4 " thick slab	26	8250	382	226	142	92	59	37			
	24	10980	524	318	206	139	95	65	44		
	22	13740	667	410	270	186	131	93	67	46	
4½" thick slab	26	9450	438	260	164	107	69	43	24		
	24	12600	601	366	238	160	110	75	51	33	
	22	15750	766	471	311	214	151	107	77	55	37
5 " thick slab	26	10680	496	295	187	121	79	50	29		
	24	14220	680	414	270	182	125	86	59	38	
	22	17790	866	533	353	242	171	123	89	62	42
5½" thick slab	26	11880	552	330	209	136	89	56	33		
	24	15840	759	462	301	203	140	97	66	43	26
	22	19800	964	594	393	270	192	138	99	70	49

Maximum Spans for Deep-Rib Hy-Rib as Centering

To support various thicknesses to wet concrete. For greater spans use temporary supports.

Gauge of Deep-Rib Hy-Rib	THICKNESS OF SLAB								
	2"	2½"	3"	3½"	4"	4½"	5"	5½"	6"
No. 22	5′ 6″	5′ 0″	4′ 6″	4′ 2″	3′11″	3′ 9″	3′ 7″	3′ 4″	3′ 2″
No. 24	5′ 0″	4′ 6″	4′ 0″	3′ 9″	3′ 6″	3′ 4″	3′ 2″	3′ 0″	2′10″
No. 26	4′ 4″	3′10″	3′ 6″	3′ 3″	3′ 1″	2′11″	2′ 9″	2′ 8″	2′ 6″

See page 26 for description of Deep-Rib Hy-Rib.

Safe Live Loads in Pounds per Square Foot for Square Panels of Steel Floredome Construction of Various Thicknesses

Depth	6″ Dome + 2″ Concrete				8″ Dome + 2″ Concrete				10″ Dome + 2″ Concrete			12″ Dome + 2″ Concrete		
*Wt. of floor in pounds pr sq. ft	50				60				71			82		
Reinforcement	½″x1½″ Kahn Bars	½″x1½″ Kahn Bars and ⅜″ Rib Bars nested	½″x1½″ Kahn Bars and ½″ Rib Bars nested	¾″x2 3/16″ Kahn Bars	½″x1½″ Kahn Bars and ½″ Rib Bars nested	¾″x2 3/16″ Kahn Bars	¾″x2 3/16″ Kahn Bars and ⅜″ Rib Bars nested	¾″x2 3/16″ Kahn Bars and ½″ Rib Bars nested	¾″x2 3/16″ Kahn Bars and ⅜″ Rib Bars nested	¾″x2 3/16″ Kahn Bars and ½″ Rib Bars nested	¾″x2 3/16″ Kahn Bars and ⅝″ Rib Bars nested	¾″x2 3/16″ Kahn Bars and ½″ Rib Bars nested	¾″x2 3/16″ Kahn Bars and ⅝″ Rib Bars nested	¾″x2 3/16″ Kahn Bars and ¾″ Rib Bars nested
Span in Feet														
8	515	680	833	1004	1094	1322	1565	1757	1920	2160	2460	2570	2920	3360
9	396	527	644	781	849	1027	1220	1372	1515	1700	1940	2020	2300	2650
10	311	418	512	623	675	820	977	1190	1210	1360	1554	1620	1850	2130
11	249	336	414	506	548	667	797	898	987	1113	1277	1337	1521	1759
12	202	274	341	418	452	552	661	746	821	926	1061	1105	1263	1454
13	163	225	281	347	374	460	551	624	684	772	888	922	1057	1219
14	134	187	235	291	313	386	465	527	578	655	753	781	895	1039
15	110	157	200	249	266	330	400	454	498	565	651	674	774	898
16	91	132	170	213	228	284	346	394	430	490	565	585	672	783
17	75	111	144	182	194	244	298	340	371	423	491	507	585	682
18	61	94	123	157	167	211	259	298	324	370	430	443	514	600
19	50	79	104	135	143	182	226	260	283	324	377	386	458	525
20	40	67	90	118	124	159	198	228	250	287	333	344	400	470
21	31	55	77	102	105	138	173	202	218	251	296	302	354	418
22	25	46	66	89	92	122	154	180	195	225	266	270	317	374
23	...	38	55	77	79	105	134	158	171	198	235	240	282	335
24	...	31	47	66	67	92	119	140	151	178	211	212	250	299
25	...	25	40	57	57	80	105	125	134	158	190	190	226	272
26	...	...	33	50	50	71	94	112	120	142	171	171	205	246

Joists are 4″ wide at base and spaced 2′-1½″ c. to c. in both directions.

Safe Live Loads for Rectangular Panels are equal to one-half the sum of loads opposite each span in above table. For instance: Panel 8 x 16 feet, 6″ Dome + 2″ Concrete, reinforced with ½″ x 1½″ Kahn bars.

$$\text{Safe live load per sq. ft.} = \frac{515 + 91}{2} = 303 \text{ lbs.}$$

*Weight of floor given above does not include weight of ceiling.

See page 18 for full description of Floredome construction.

See explanation of tables page 90.

Safe Live Loads in Pounds per Square Foot for Steel Floretyle Construction of Various Thicknesses

Depth	6″ Tyle + 2″ Concrete				8″ Tyle + 2″ Concrete				10″ Tyle + 2″ Concrete			12″ Tyle + 2″ Concrete		
*Wt. of floor in pounds per sq. ft	41				46				51			56		
Reinforcement	½″x1½″ Kahn Bars	½″x1½″ Kahn Bars and ⅜″ Rib Bars nested	½″x1½″ Kahn Bars and ½″ Rib Bars nested	¾″x2 3/16″ Kahn Bars	½″x1½″ Kahn Bars and ½″ Rib Bars Nested	¾″x2 3/16″ Kahn Bars	¾″x2 3/16″ Kahn Bars and ⅜″ Rib Bars nested	¾″x2 3/16″ Kahn Bars and ½″ Rib Bars nested	¾″x2 3/16″ Kahn Bars and ⅜″ Rib Bars nested	¾″x2 3/16″ Kahn Bars and ½″ Rib Bars nested	¾″x2 3/16″ Kahn Bars and ⅝″ Rib Bars nested	¾″x2 3/16″ Kahn Bars and ½″ Rib Bars nested	¾″x2 3/16″ Kahn Bars and ⅝″ R b Bars nested	¾″x2 3/16″ Kahn Bars and ¾″ Rib Bars nested
Span in Feet														
8	213	295	355	438	467	574	679	759	842	939	1060	1123	1268	1444
9	160	224	271	337	359	444	527	589	654	732	829	874	992	1130
10	121	174	212	265	282	351	419	469	520	582	660	697	794	905
11	93	136	168	212	226	282	338	380	421	473	538	567	645	739
12	72	108	135	171	182	230	276	312	346	389	443	467	534	611
13	55	86	109	140	148	189	228	260	287	324	369	389	446	513
14	42	69	88	115	121	156	191	217	240	273	312	328	377	434
15	31	54	71	95	100	131	160	183	203	231	266	279	321	371
16	22	43	58	78	82	109	135	155	172	197	221	238	275	320
17	....	33	47	65	68	91	115	132	147	168	196	205	238	277
18	....	25	37	54	55	77	97	113	125	145	169	176	206	241
19	....	....	29	44	45	64	82	97	107	125	146	152	179	210
20	....	....	23	36	36	53	70	83	92	107	127	132	156	184
21	....	....	....	28	28	44	59	71	78	93	110	115	136	162
22	....	....	....	....	22	36	50	61	67	80	96	100	119	142
23	....	....	....	....	....	29	42	52	57	69	84	87	105	126
24	....	....	....	....	....	23	34	43	48	59	72	74	91	111
25	....	....	....	....	....	....	28	36	40	50	63	64	80	97
26	....	....	....	....	....	....	22	30	33	42	54	55	69	86

All joists are 4″ wide at base and spaced 2′-0″ c. to c.

B. M. = $1/10\ wl^2$.

*Weight of floor given does not include weight of ceiling.

See page 19 for full description of Floretyle Construction.

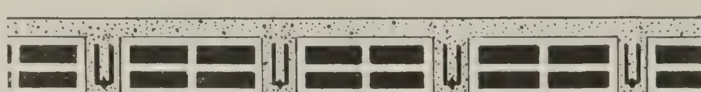
See explanation of tables page 90.

Safe Live Loads per Square Foot for Hollow Terra Cotta Tile Floors of Various Thicknesses

Reinforced with ½″x1½″ Kahn Trussed Bars

Depth	4″ Tile + 1″ Concrete	4″ Tile + 2″ Concrete	6″ Tile + 1″ Concrete	6″ Tile + 2″ Concrete	8″ Tile + 1″ Concrete	8″ Tile + 2″ Concrete	10″ Tile	10″ Tile + 1″ Concrete	10″ Tile + 2″ Concrete	12″ Tile	12″ Tile + 1″ Concrete	12″ Tile + 2″ Concrete
Wght. of floor in pounds per sq. ft.	38	50	47	59	56	68	54	66	78	63	75	87
Spacing	<— 16″ C. to C —>											
Span in Feet												
6	378	464	565	651	752	838	852	938	1024	1039	1125	1211
7	268	328	403	462	538	598	612	672	732	747	807	867
8	196	239	297	340	398	442	456	499	542	557	600	643
9	147	178	225	256	303	335	349	380	412	427	458	490
10	112	135	173	196	235	258	272	295	319	334	357	380
11	86	103	135	152	184	202	216	233	250	265	282	299
12	66	78	106	118	146	159	173	185	197	212	225	237
13		59	83	92	116	125	139	148	157	172	181	190
14		44	65	71	92	98	112	118	124	139	145	151
15		32	51	54	73	77	91	95	98	113	117	121
16			39	41	58	59	73	75	77	92	94	96
17			29	29	45	45	59	59	59	74	75	75
18					34	33	47	45	44	59	58	57
19					25		36	34	32	47	45	42
20							28			36	33	30
21										27		

$$B.M. = \frac{wl^2}{10}$$



See explanation of tables page 90.

Safe Live Loads per Square Foot for Hollow Terra Cotta Tile Floors of Various Thicknesses

Reinforced with ½"x1½" Kahn Trussed Bars

Depth	4" Tile + 1" Concrete	4" Tile + 2" Concrete	6" Tile + 1" Concrete	6" Tile + 2" Concrete	8" Tile + 1" Concrete	8" Tile + 2" Concrete	10" Tile	10" Tile + 1" Concrete	10" Tile + 2" Concrete	12" Tile	12" Tile + 1" Concrete	12" Tile + 2" Concrete
Weight of Floor in Pounds Per sq. ft.	39	51	49	61	59	71	58	70	82	68	80	92
Spacing	< 17" C. to C. >											
Span in Feet												
6	352	433	524	606	700	780	793	874	950	964	1046	1128
7	249	304	372	429	498	555	568	624	679	693	748	804
8	181	221	273	314	368	408	421	461	501	515	554	594
9	135	164	205	236	279	308	321	350	378	392	421	450
10	102	123	157	180	215	236	249	270	291	305	326	348
11	77	93	122	136	167	184	197	211	226	240	255	271
12	59	70	94	106	131	143	156	166	177	191	202	213
13		52	73	81	103	111	124	131	139	153	160	167
14		38	56	61	80	86	99	104	108	122	127	132
15			43	46	62	65	78	81	84	98	100	103
16			31	33	48	49	62	63	64	78	79	80
17					36	35	48	48	47	61	60	60
18						24	37	35	33	47	45	44
19									21	35	32	30

$$B.\ M.\ \frac{wl}{10}$$

See explanation of tables page 90.

Safe Live Loads per Square Foot for Hollow Terra Cotta Tile Floors of Various Thicknesses

Reinforced with $\frac{3}{4}''$x$2\frac{3}{16}''$ and $1\frac{1}{2}''$x$2\frac{1}{4}''$ Kahn Trussed Bars

	$\frac{3}{4}''$ x $2\frac{3}{16}''$ BARS										$1\frac{1}{2}$x$2\frac{1}{4}$
DEPTH	6″ Tile + 2″ Concrete	8″ Tile + 2″ Concrete	10″ Tile + 2″ Concrete	12″ Tile + 2″ Concrete	12″ Tile + 2″ Concrete	12″ Tile + 2″ Concrete	6″ Tile + 2″ Concrete	8″ Tile + 2″ Concrete	10″ Tile + 2″ Concrete	12″ Tile + 2″ Concrete	12″ Tile + 3″ Concrete
Weight of Floor in Pounds Per sq. ft.	59	68	78	87	98	104	61	71	82	92	108
Spacing	<——16″ C to C——>				15″	13″	<—— 17″ C to C ——>				18″
SPAN IN FEET 8	686	887	1090	1293	1374	1595	639	827	1018	1208	2167
9	528	687	845	1003	1065	1238	492	638	786	935	1687
10	416	543	669	796	844	983	387	504	621	739	1347
11	334	437	540	643	681	795	309	404	499	595	1094
12	271	357	441	526	556	651	250	329	406	485	902
13	222	294	364	436	459	539	204	269	334	399	752
14	182	244	303	363	383	451	167	222	276	332	634
15	152	204	254	306	321	379	138	185	230	277	538
16	127	171	214	257	270	320	114	154	193	233	460
17	106	144	181	218	228	272	94	128	161	196	395
18	88	121	153	185	193	231	77	107	135	165	341
19	73	101	129	157	163	197	63	88	113	138	295
20	60	85	109	133	137	167	51	73	94	116	256
21	49	71	92	113	116	142		59	77	97	222
22	39	58	76	95	97	121		48	63	80	192
23		47	63	80	80	101		38	51	65	167
24		38	52	66	66	85		29	40	52	145
25			42	54	53	70			30	41	125
26			33	43	41	57				31	107
27				34	31	45					92
28											78
29											65
$B. M. = \frac{wl^2}{10}$					10″ Tile on Edge	8″ Tile on Edge					

See explanation of tables page 90.

Safe Live Loads per Square Foot for Hollow Terra Cotta Tile Floors of Various Thicknesses

Reinforced with $\frac{1}{2}''$x$1\frac{1}{2}''$ and $\frac{3}{4}''$x$2\frac{3}{16}''$ Kahn Trussed Bars Spaced Alternately

DEPTH	4″ Tile + 2″ Concrete	6″ Tile + 1″ Concrete	6″ Tile + 2″ Concrete	8″ Tile + 1″ Concrete	8″ Tile + 2″ Concrete	10″ Tile + 1″ Concrete	10″ Tile + 2″ Concrete	12″ Tile + 1″ Concrete	12″ Tile + 2″ Concrete
Weight of Floor in Pounds Per sq. ft.	50	47	59	56	68	66	78	75	87
Spacing	<—				16″ C. to C.				—>
SPAN IN FEET 7	447	583	678	787	880	987	1080	1189	1282
8	353	435	505	589	658	740	809	893	961
9	267	334	387	454	505	571	623	690	741
10	206	262	302	357	396	450	489	544	584
11	163	208	239	285	316	360	391	437	467
12	129	167	191	231	255	292	316	355	379
13	103	135	154	188	207	239	258	291	310
14	82	110	125	155	169	197	212	241	255
15	64	90	101	128	138	163	174	200	211
16		73	82	105	113	136	144	167	175
17		60	66	87	93	113	118	139	145
18			52	71	75	93	97	116	120
19			41	58	61	77	79	97	99
20			31	47	48	63	64	80	81
21				38	37	51	51	65	65
22				29	28	41	39	53	52
23						32	29	42	40
24								32	29

$$B.\,M. = \frac{wl^2}{10}$$

See explanation of tables page 90.

Safe Live Loads per Square Foot for Hollow Terra Cotta Tile Floors of Various Thicknesses

Reinforced with ½"x1½" and ¾"x2$\frac{3}{16}$" Kahn Trussed Bars Spaced Alternately

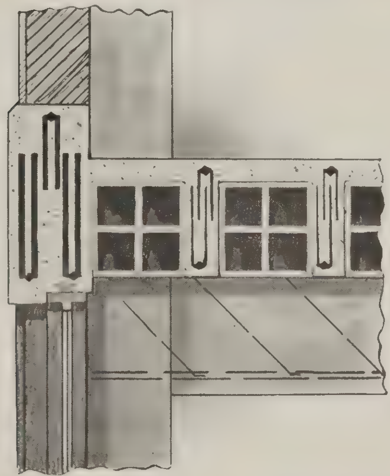
Depth	4" Tile + 2" Concrete	6" Tile + 1" Concrete	6" Tile + 2" Concrete	8" Tile + 1" Concrete	8" Tile + 2" Concrete	10" Tile + 1" Concrete	10" Tile + 2" Concrete	12" Tile + 1" Concrete	12" Tile + 2" Concrete
Weight of Floor in Pounds Per sq. ft.	51	49	60	59	71	70	82	80	92
Spacing	< 17" C. to C.								
SPAN IN FEET									
7	446	544	635	734	821	921	1008	1109	1196
8	329	405	472	548	612	689	753	830	894
9	250	310	361	421	469	529	577	639	687
10	193	242	280	330	366	416	452	503	539
11	151	191	222	262	290	331	359	402	430
12	119	153	177	211	233	267	289	325	346
13	94	123	142	171	188	217	234	265	281
14	74	99	114	139	152	178	191	217	230
15	58	80	92	114	123	146	155	179	188
16		65	74	93	100	120	127	148	155
17		51	59	76	80	98	103	122	126
18			46	61	64	80	83	100	103
19			35	49	50	64	66	81	83
20				38	38	51	52	66	66
21				29	28	40	39	52	51
22						30	28	40	38
23								30	27

$$B.M. = \frac{wl^2}{10}$$

See explanation of tables page 90.

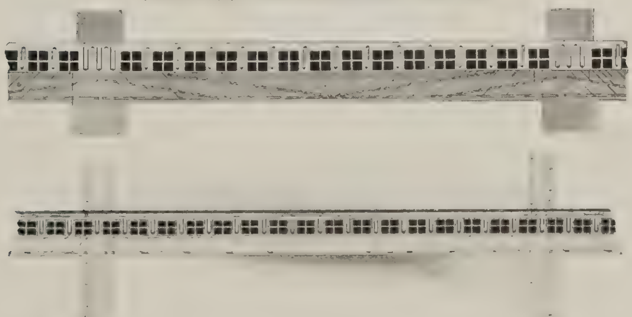
Kahn Trussed Bar

Note rigidly connected shear members.



Detail of Window Framing Into Concrete Lintel Beam.

Cross Section Reinforced Hollow Tile Floor.



Detail of Framing Reinforced Concrete Columns, Beams and Floors.

Explanation of Tables of Safe Loads for Beams

The tables for beams on pages 109 to 115, give the loads in pounds, uniformly distributed for all usual spans, based upon a fibre stress of 16,000 pounds per square inch in the steel.

These loads include the weight of the beam, which must be deducted in order to arrive at the net load which the beam will carry.

The carrying capacities in the tables are based on beams freely supported at the ends and uniformly loaded; that is, $BM = \frac{Wl}{8}$

In building construction it is usual to take advantage of continuous action and to provide reinforcement at the top of the beam over the supports.

For continuous beams, the Bending Moment at the center of the spans may be considerably reduced. If the value of this Bending Moment is taken as $\frac{Wl}{K}$, the safe loads given in tables must be multiplied by $\frac{K}{8}$ and reinforcement must be provided in top of beams over both supports at least equal in area to $\frac{K-8}{8}$ times the area of steel at center of span.

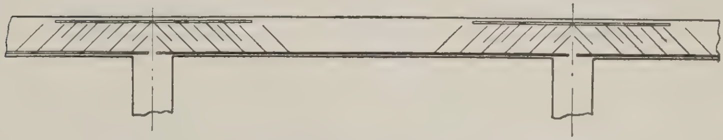
Where the area of steel reinforcement exceeds one per cent. of the area of the concrete, above the steel the beam must be made of T section. This can be readily done by using table on page 61 for ratio of width of T to width of beam.

For beams carrying plastered ceiling, it is found by experience that their depth should be at least 1-15 of the clear span; where this limit is exceeded there is danger of the ceiling cracking.

These tables show beams reinforced with two Kahn bars alone, and also with two Kahn bars with an additional Rib Bar bent over the supports. Other combinations of reinforcement will suggest themselves so that any size and condition of loading can be readily provided for. Our engineers will gladly furnish detailed suggestions on the design of reinforced concrete beams.

The web members must be bent up at an angle of at least 45 degrees with the main section and should be of sufficient length to reach nearly the top of beam. For standard and special lengths of diagonals, see pages 14 to 17.

Safe Total Loads in Hundreds of Pounds Uniformly Distributed for Concrete Beams



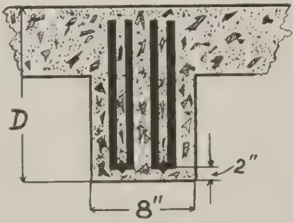
Reinforced with Two $\frac{3}{4}$"x2$\frac{3}{16}$" Kahn Trussed Bars
Area = 1.58 sq. in.

Span in Feet	Depth in Inches (*D*)					
	8	10	12	14	16	18
7	124	166	207			
8	109	145	181	217		
9	97	129	161	193	225	258
10		116	145	174	203	232
11		106	132	158	184	211
12		97	121	145	169	193
13			111	134	156	178
14			104	124	145	166
15			97	116	135	155
16				109	127	145
17				102	119	136
18				97	113	129
19					107	122
20					101	116
21					97	110
22						105
23						101

NOTE:—Make Beam of T Section.
D=Total depth of Beam in inches.

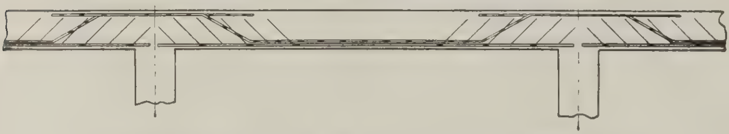
$B.\ M. = \frac{Wl}{8}$

NOTE:—For B. M. $= \frac{Wl}{K}$ above loads must be multiplied by $\frac{K}{8}$



See explanation of tables page 108.

Safe Total Load in Hundreds of Pounds Uniformly Distributed for Concrete Beams



Reinforced with Two $\frac{3}{4}''$x$2\frac{3}{16}''$ Kahn Trussed Bars and One $\frac{3}{4}''$ Rib Bar. Area 2.14 sq. in.

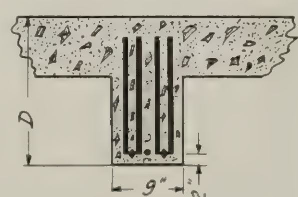
Span in Feet	Depth in Inches (*D*)							
	10	12	14	16	18	20	22	24
9	174	218						
10	157	196	235					
11	143	178	214	250				
12	131	164	196	229	262	294		
13		151	181	211	242	272	302	332
14		140	168	196	224	252	280	308
15		131	157	183	209	235	262	288
16			147	172	196	221	245	270
17			139	162	185	208	231	254
18				153	174	196	218	240
19				145	165	186	207	227
20				137	157	177	196	216
21					149	168	187	206
22					142	161	178	196
23						154	171	188
24						147	163	180
25						141	157	173
26							151	166
27							145	160
28							140	154
29								149
30								144

NOTE:—Make Beam of T Section.

D = Total depth of Beam in inches.

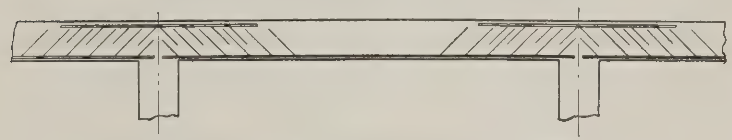
$B. M. = \frac{Wl}{8}$

NOTE:—For B. M. $= \frac{Wl}{K}$ above loads must be multiplied by $\frac{K}{8}$



See explanation of tables page 108.

Safe Total Loads in Hundreds of Pounds Uniformly Distributed for Concrete Beams



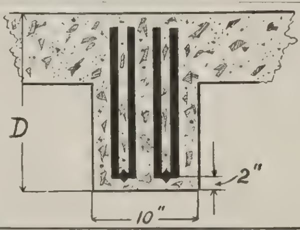
Reinforced with Two 1½″x2¼″ Kahn Trussed Bars
Area = 2.82 sq. in.

Span in Feet	Depth in Inches (D)									
	12	14	16	18	20	22	24	26	28	30
12	216	259	302							
13	199	239	278	318	358					
14	185	222	259	296	332	370	406			
15	172	207	241	276	310	345	379	414	448	
16		194	226	259	291	323	356	388	420	453
17		182	213	244	274	304	335	365	396	426
18			201	230	258	287	316	345	374	402
19			190	218	245	272	300	327	354	381
20			181	207	233	258	284	310	336	362
21				197	222	246	271	295	320	345
22				188	212	235	259	282	305	329
23				180	202	225	247	270	292	315
24					194	216	237	258	280	302
25					186	207	228	248	269	290
26						199	219	239	258	278
27						191	211	230	249	268
28						185	203	221	240	258
29							196	214	232	250
30							189	207	224	241
31								200	217	233
32								194	210	226
33								188	204	219
34									198	213
35									192	207
36										201
37										196
38										191

NOTE:—Made Beam of T Section.
D=Total depth of Beam in inches.

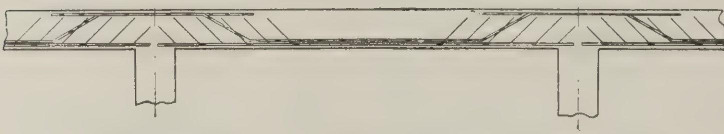
$B.\ M. = \frac{Wl}{8}$

NOTE:—For B. M. $= \frac{Wl}{K}$ above loads must be multiplied by $\frac{K}{8}$



See explanation of tables page 108.

Safe Total Loads in Hundreds of Pounds Uniformly Distributed for Concrete Beams



Reinforced with two $1\frac{1}{2}''$x$2\frac{1}{4}''$ Kahn Trussed Bars and One $\frac{3}{4}''$ Rib Bar. Area 3.38 sq. in.

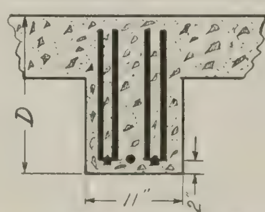
Span in Feet	Depth in Inches (D)									
	14	16	18	20	22	24	26	28	30	32
13	286									
14	266	310	354							
15	246	289	330	372						
16	232	271	310	348	387	426				
17	219	255	292	328	365	400	438	474	510	
18		241	275	310	344	379	413	448	482	517
19		228	261	294	326	359	392	424	456	489
20		217	248	279	310	341	372	403	434	465
21			236	266	295	324	354	384	413	443
22			225	254	282	310	338	366	394	423
23			216	243	269	296	323	350	377	404
24				232	258	284	310	336	362	387
25				223	248	272	298	322	347	372
26					238	262	286	310	334	357
27					229	253	276	298	321	344
28					221	244	266	288	310	332
29						235	257	278	299	321
30						227	248	268	289	310
31							240	260	280	300
32							232	252	271	291
33							225	244	263	282
34								237	255	274
35								230	248	266
36									241	258
37									234	252
38									228	245

NOTE:—Make Beam of T Section.

D=Total depth of Beam in inches.

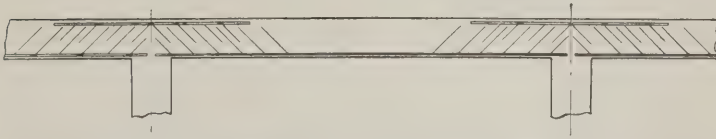
$B.\ M. = \frac{Wl}{8}$

NOTE:—For B. M. $= \frac{Wl}{K}$ above loads must be multiplied by $\frac{K}{8}$



See explanation of tables, page 108.

Safe Total Loads in Hundreds of Pounds Uniformly Distributed for Concrete Beams



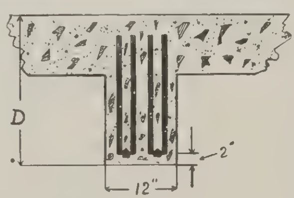
Reinforced with Two $1\frac{3}{4}''$x$2\frac{3}{4}''$ Kahn Trussed Bars. Area = 4 sq. in.

Span in Feet	Depth in Inches (*D*)									
	16	18	20	22	24	26	28	30	32	34
18	285	326	367	408	448					
19	270	309	348	386	425	463	502			
20	257	294	330	367	404	440	477	514		
21		280	314	349	384	419	454	489	524	
22		267	300	334	367	400	434	467	500	534
23		255	287	319	351	383	415	447	479	510
24			275	306	336	367	398	428	459	489
25			264	294	323	352	382	411	440	470
26				282	310	339	367	395	423	452
27				272	299	326	353	380	408	435
28				262	288	314	341	367	393	419
29					278	304	329	354	380	405
30					269	294	318	342	367	391
31						284	308	331	355	379
32						275	298	321	344	367
33						267	289	311	334	356
34							280	302	324	346
35							272	294	314	336
36								286	306	326
37								278	298	318

NOTE:—
Make Beam of T Section.

D = Total depth of Beam in inches.

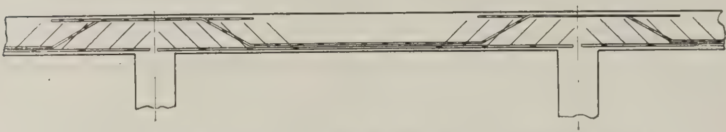
$$B.\,M. = \frac{Wl}{8}$$



NOTE: —For B. M. = $\frac{Wl}{K}$ above loads must be multiplied by $\frac{K}{8}$

See explanation of tables page 108.

Safe Total Loads in Hundreds of Pounds Uniformly Distributed for Concrete Beams



Reinforced with Two $1\frac{3}{4}''$x$2\frac{3}{4}''$ Kahn Trussed Bars and One 1″ Rib Bar. Area = 5 sq. in.

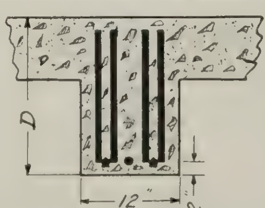
Span in Feet	Depth in Inches (D)									
	18	20	22	24	26	28	30	32	34	36
18	408									
19	386	435								
20	367	414	458							
21	350	394	436	481	524					
22	334	376	416	458	500	541	582			
23	319	360	399	439	478	518	558	599	638	
24		345	382	421	458	496	535	573	610	650
25		331	367	404	440	476	515	550	588	624
26			353	389	423	458	493	530	565	600
27			340	375	407	441	476	510	544	577
28			327	361	393	426	458	492	524	557
29				349	379	411	444	475	506	538
30				337	367	397	429	460	489	520
31					355	385	415	445	474	503
32					344	373	402	430	458	487
33					334	361	390	418	445	473
34						350	378	405	432	459
35						341	368	394	420	446
36							358	383	408	433
37							348	373	397	421
38							339	363	386	410
39								354	376	400
40								345	369	390

NOTE:—Make Beam of T Section.

D = Total depth of Beam in inches.

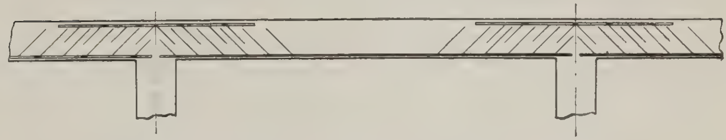
$B.\ M. = \frac{Wl}{8}$

NOTE:—For B. M. = $\frac{Wl}{K}$ above loads must be multiplied by $\frac{K}{8}$



See explanation of tables page 108.

Safe Total Loads in Hundreds of Pounds Uniformly Distributed for Concrete Beams



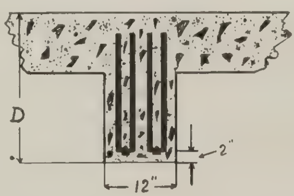
Reinforced with Two 2″x3½″ Kahn Trussed Bars
Area = 6 sq. in.

Span in Feet	Depth in Inches (D)						
	24	26	28	30	32	34	36
25	484	528	572	616			
26	466	508	550	593	635		
27	448	489	530	571	612	652	
28	432	472	511	550	590	629	668
29	418	456	493	531	569	607	645
30	404	440	477	514	550	587	624
31		426	462	497	532	568	604
32		413	447	482	516	550	585
33		400	434	467	500	534	567
34			421	453	486	518	550
35			409	440	472	503	535
36				428	459	489	520
37				417	446	476	506
38				406	435	464	492
39					424	452	480
40					413	440	468

NOTE:—Make Beam of T Section.

D = Total depth of Beam in inches.

$$B.\ M. = \frac{Wl}{8}$$



NOTE:—For B. M. = $\frac{Wl}{K}$ above loads must be multiplied by $\frac{K}{8}$

See explanation of tables page 108.

Safe Loads in Thousands of Pounds for Square, Stayed Columns of Reinforced Concrete

No. of Verticals	4	4	6	4	6	4	6	4	6	6	8	10
Size of Rib Bars	5/8″	3/4″	5/8″	7/8″	3/4″	1″	7/8″	1 1/8″	1″	1 1/8″	1 1/8″	1 1/8″
Size of Square Columns in Inches												
12	83	88	89	93	96							
13	95	100	101	105	108	112						
14	109	114	115	119	122	126	130					
15	123	128	129	133	135	140	144	147				
16	139	144	145	149	152	156	160	163	170			
17	155	160	161	165	168	172	176	179	186			
18		178	179	183	186	190	194	197	204			
19		196	197	201	204	208	212	215	222	233		
20		216	217	221	224	228	232	235	242	253		
21		236	237	241	244	248	252	255	262	273	291	
22			259	263	266	270	274	277	284	295	313	
23				286	289	293	297	300	307	318	336	354
24				309	312	316	320	323	330	341	359	377
25					336	340	344	347	354	365	383	401
26					362	366	370	373	380	391	409	427
27						393	397	400	407	418	436	454
28						420	424	427	434	445	463	481
29							452	455	462	473	491	509
30							482	485	492	503	521	539
31								516	523	534	552	570
32									554	565	583	601
33									586	597	615	633
34									619	630	648	666
35										665	683	701
36										701	719	737

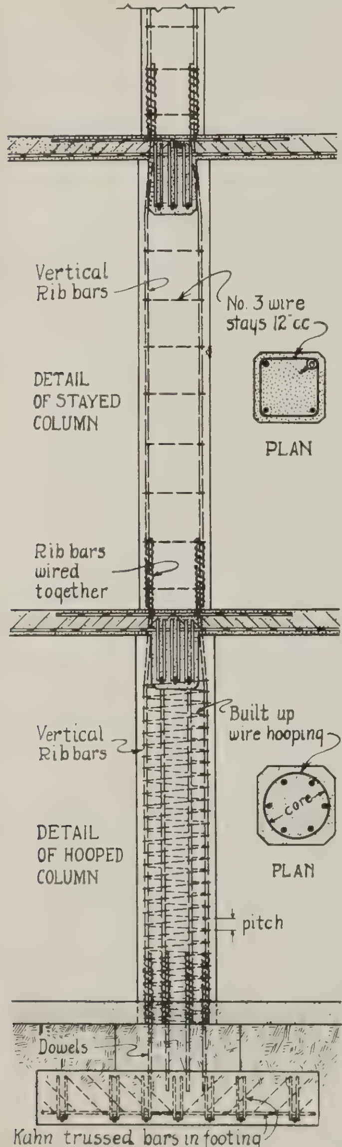
NOTE:—
Minimum Vertical Steel = ½%.
Middle Heavy Line indicates 1% Vertical Steel.
Maximum Vertical Steel = 2¼% (Steel Carrying 25% of Load.)

Above loads commuted by formulae:
Safe Load = 500 (Ac + 15 As.)
Ac = Area of Concrete. As = Area of Vertical Steel.
Stress on Concrete = 500 lbs. per sq. in. For other stresses on concrete, Safe Loads will be proportional.
Concrete mixture for columns; 1:1½:3—Vertical Steel is stayed every 12 inches with No. 3 (5/16 in. diameter) wire, extending around column.
Least width of Column should not exceed 1-15 of its unsupported length.
Reduce Loads for eccentric loading, bending strains, etc.
See page 68 for Discussion of Unhooped Columns.

Safe Loads Carried by Hooped Columns

SAFE LOADS In Pounds	Outside Diameter	Core Diameter	Number of Verticals	Size of Verticals	Size of Hooping Wire Diameter	Pitch of Hooping Centers
125000	16″	12″	6	⅝″ Rib Bar	5/16″	3½″
150000	18″	14″	6	⅝″ Rib Bar	5/16″	3 ″
175000	18″	14″	6	¾″ Rib Bar	5/16″	3 ″
200000	20″	16″	6	⅝″ Rib Bar	5/16″	3 ″
225000	20″	16″	6	⅞″ Rib Bar	5/16″	3 ″
	20″	16″	6	¾″ Rib Bar	5/16″	2½″
250000	20″	16″	6	1 ″ Rib Bar	5/16″	2½″
	20″	16″	6	⅞″ Rib Bar	⅜″	3 ″
275000	20″	16″	6	1 ″ Rib Bar	⅜″	2½″
	22″	18″	6	⅞″ Rib Bar	5/16″	3 ″
300000	22″	18″	6	1⅛″ Rib Bar	5/16″	3 ″
	22″	18″	6	1 ″ Rib Bar	⅜″	3 ″
325000	22″	18″	6	1⅛″ Rib Bar	⅜″	3 ″
	22″	18″	6	1 ″ Rib Bar	⅜″	2½″
350000	22″	18″	8	1 ″ Rib Bar	⅜″	2½″
	24″	20″	8	1 ″ Rib Bar	5/16″	3 ″
375000	24″	20″	6	1¼″ Rib Bar	5/16″	3 ″
	24″	20″	8	1 ″ Rib Bar	⅜″	3 ″
	24″	20″	6	1 ″ Rib Bar	⅜″	2½″
400000	24″	20″	6	1¼″ Rib Bar	⅜″	3 ″
	24″	20″	8	1 ″ Rib Bar	⅜″	2½″
	24″	20″	6	1 ″ Rib Bar	⅜″	2 ″
425000	24″	20″	8	1⅛″ Rib Bar	⅜″	2½″
	24″	20″	8	1 ″ Rib Bar	⅜″	2 ″
450000	24″	20″	8	1⅛″ Rib Bar	⅜″	2 ″
	26″	22″	8	1 ″ Rib Bar	⅜″	2½″
475000	26″	22″	8	1⅛″ Rib Bar	⅜″	2½″
	26″	22″	8	1 ″ Rib Bar	⅜″	2 ″
500000	26″	22″	8	1⅛″ Rib Bar	⅜″	2 ″
	28″	24″	8	1 ″ Rib Bar	⅜″	3 ″
525000	26″	22″	10	1⅛″ Rib Bar	⅜″	2 ″
	28″	24″	8	1⅛″ Rib Bar	⅜″	3 ″
550000	28″	24″	10	1⅛″ Rib Bar	⅜″	3 ″
	28″	24″	8	1⅛″ Rib Bar	⅜″	2½″
575000	28″	24″	10	1⅛″ Rib Bar	⅜″	2½″
	28″	24″	8	1⅛″ Rib Bar	⅜″	2 ″
600000	28″	24″	10	1⅛″ Rib Bar	⅜″	2 ″
	28″	24″	8	1⅛″ Rib Bar	⅜″	1½″
625000	28″	24″	10	1⅛″ Rib Bar	⅜″	1½″
650000	30″	26″	10	1⅛″ Rib Bar	⅜″	2 ″
675000	30″	26″	10	1⅛″ Rib Bar	⅜″	2 ″
	30″	26″	8	1⅛″ Rib Bar	⅜″	1½″
700000	30″	26″	10	1⅛″ Rib Bar	⅜″	1½″
	32″	28″	10	1⅛″ Rib Bar	⅜″	2½″
750000	30″	26″	10	1¼″ Rib Bar	⅜″	1½″
	32″	28″	10	1¼″ Rib Bar	⅜″	2½″
	32″	28″	10	1⅛″ Rib Bar	⅜″	2 ″
800000	32″	28″	10	1¼″ Rib Bar	⅜″	1½″
	34″	30″	10	1⅛″ Rib Bar	⅜″	2 ″
850000	34″	30″	10	1¼″ Rib Bar	⅜″	2 ″
	34″	30″	10	1⅛″ Rib Bar	⅜″	1½″

Concrete mixture for these columns should be 1:1½:3.
Above table is for hooped columns loaded symmetrically; reduce loads for eccentric loading, bending strains, etc.
Least width of column should not exceed 1/15 of its unsupported length.
Due allowance must be made for eccentric loading, bending, etc.
See page 68 for Theory of Hooped Columns.



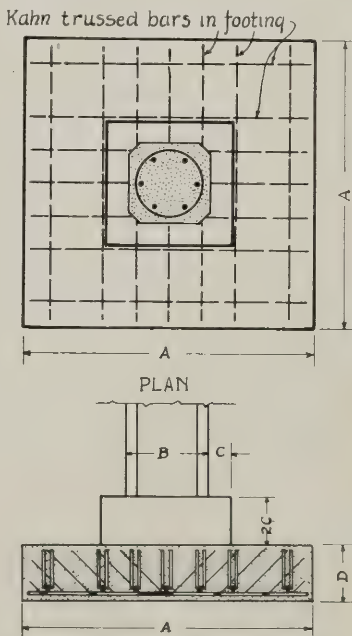
TYPICAL COLUMN DETAIL

Footing Tables

The tables given on pages 119 to 121 are for square footings. Soil values from 1 to 5 tons have been assumed, and the footings figured for column loads from 75,000 pounds to 600,000 pounds, varying by 25,000 pounds.

The tables show the total number of Kahn Bars required in each footing, half the number being placed in each direction as shown.

The footings are figured for a depth of footing slab as indicated in tables. The cap at the foot of the column is to have a projection C from the face of the column of 6″ for columns less than 24″ in least diameter and 8″ where the column is 24″ and over. The depth of the cap should be twice this projection.



TYPICAL COLUMN FOOTING DETAIL

Table of Reinforced Concrete Footings

Soil Value per Sq. Foot	2000 Lbs.				2500 Lbs.				3000 Lbs.			
Load in Lbs. on Footing	Size of Footing		Kahn Trussed Bars		Size of Footing		Kahn Trussed Bars		Size of Footing		Kahn Trussed Bars	
	Square	Depth	No.	Size	Square	Depth	No.	Size	Square	Depth	No.	Size
75000	6'-3"	1'- 3"	16	½"x1½"	5'-6"	1'- 1"	14	½"x1½"	5'-0"	1'- 0"	14	½"x1½"
100000	7'-0"	1'- 5"	18	½"x1½"	6'-3"	1'- 3"	20	½"x1½"	5'-9"	1'- 2"	16	½"-1½"
125000	8'-0"	1'- 7"	16	¾"x2 3/16"	7'-0"	1'- 5"	14	¾"x2 3/16"	6'-6"	1'- 3"	12	¾"x2 3/16"
150000	8'-9"	1'- 9"	16	¾"x2 3/16"	7'-9"	1'- 6"	16	¾"x2 3/16"	7'-0"	1'- 5"	14	¾"x2 3/16"
175000	9'-6"	1'-11"	18	¾"x2 3/16"	8'-6"	1'- 8"	18	¾"x2 3/16"	7'-9"	1'- 7"	16	¾"x2 3/16"
200000	10'-0"	2'- 0"	20	¾"x2 3/16"	9'-0"	1'- 9"	22	¾"x2 3/16"	8'-3"	1'- 8"	18	¾"x2 3/16"
225000	10'-6"	2'- 1"	24	¾"x2 3/16"	9'-6"	1'-11"	22	¾"x2 3/16"	8'-9"	1'- 9"	20	¾"x2 3/16"
250000	11'-3"	2'- 3"	26	¾"x2 3/16"	10'-0"	2'- 0"	24	¾"x2 3/16"	9'-3"	1'-10"	22	¾"x2 3/16"
275000	11'-9"	2'- 4"	28	¾"x2 3/16"	10'-6"	2'- 1"	18	1½"x2¼"	9'-6"	1'-11"	24	¾"x2 3/16"
300000	12'-3"	2'- 5"	30	¾"x2 3/16"	11'-0"	2'- 2"	20	1½"x2¼"	10'-0"	2'- 0"	28	¾"x2 3/16"
325000	12'-9"	2'- 6"	20	1½"x2¼"	11'-6"	2'- 3"	20	1½"x2¼"	10'-6"	2'- 1"	20	1½"x2¼"
350000	13'-3"	2'- 8"	22	1½"x2¼"	12'-0"	2'- 5"	22	1½"x2¼"	10'-9"	2'- 2"	20	1½"x2¼"
375000	13'-9"	2'- 9"	22	1½"x2¼"	12'-3"	2'- 5"	22	1½"x2¼"	11'-3"	2'- 3"	20	1½"x2¼"
400000	14'-3"	2'-10"	22	1½"x2¼"	12'-9"	2'- 6"	24	1½"x2¼"	11'-6"	2'- 3"	22	1½"x2¼"
425000	14'-6"	2'-11"	24	1½"x2¼"	13'-0"	2'- 7"	24	1½"x2¼"	12'-0"	2'- 5"	22	1½"x2¼"
450000	15'-0"	3'- 0"	26	1½"x2¼"	13'-6"	2'- 8"	26	1½"x2¼"	12'-3"	2'- 5"	24	1½"x2¼"
475000	15'-6"	3'- 1"	28	1½"x2¼"	13'-9"	2'- 9"	28	1½"x2¼"	12'-6"	2'- 6"	24	1½"x2¼"
500000	15'-9"	3'- 2"	28	1½"x2¼"	14'-3"	2'-10"	30	1½"x2¼"	13'-0"	2'- 7"	26	1½"x2¼"
525000	16'-3"	3'- 3"	30	1½"x2¼"	14'-6"	2'-11"	30	1½"x2¼"	13'-3"	2'- 8"	28	1½"x2¼"
550000	16'-6"	3'- 3"	32	1½"x2¼"	14'-9"	2'-11"	30	1½"x2¼"	13'-6"	2'- 8"	28	1½"x2¼"
575000	17'-0"	3'- 5"	34	1½"x2¼"	15'-3"	3'- 0"	32	1½"x2¼"	13'-9"	2'- 9"	30	1½"x2¼"
600000	17'-3"	3'- 5"	36	1½"x2¼"	15'-6"	3'- 1"	32	1½"x2¼"	14'-3"	2'-10"	32	1½"x2¼"

Table of Reinforced Concrete Footings

Soil Value per Sq. Foot	4000 Lbs.				5000 Lbs.				6000 Lbs.			
Load in Lbs. on Footing	Size of Footing		Kahn Trussed Bars		Size of Footing		Kahn Trussed Bars		Size of Footing		Kahn Trussed Bars	
	Square	Depth	No.	Size	Square	Depth	No.	Size	Square	Depth	No.	Size
75000	4′-6″	0′-10″	14	½″x1½″	4′-0″	0′-10″	10	½″x1½″				
100000	5′-0″	1′- 0″	16	½″x1½″	4′-6″	0′-10″	16	½″x1½″	4′-0″	0′-10″	12	½″x1½″
125000	5′-6″	1′- 1″	12	¾″x2 3/16″	5′-0″	1′- 0″	18	½″x1½″	4′-6″	0′-10″	16	½″x1½″
150000	6′ 3″	1′- 3″	12	¾″x2 3/16″	5′-6″	1′- 1″	12	¾″x2 3/16″	5′-0″	1′- 0″	10	¾″x2 3/16″
175000	6′-9″	1′- 4″	14	¾″x2 3/16″	6′-0″	1′- 2″	14	¾″x2 3/16″	5′-6″	1′- 1″	12	¾″x2 3/16″
200000	7′-0″	1′- 5″	14	¾″x2 3/16″	6′-3″	1′- 3″	14	¾″x2 3/16″	5′-9″	1′- 2″	12	¾″x2 3/16″
225000	7′-6″	1′- 6″	18	¾″x2 3/16″	6′-9″	1′- 4″	16	¾″x2 3/16″	6′-3″	1′- 3″	14	¾″x2 3/16″
250000	8′-0″	1′- 7″	22	¾″x2 3/16″	7′-0″	1′- 5″	16	¾″2x 3/16″	6′-6″	1′- 8″	16	¾″x2 3/16″
275000	8′-3″	1′- 8″	22	¾″x2 3/16″	7′-6″	1′- 6″	20	¾″x2 3/16″	6′-9″	1′- 8″	18	¾″x2 3/16″
300000	8′-9″	1′- 9″	26	¾″x2 3/16″	7′-9″	1′- 7″	20	¾″x2 3/16″	7′-0″	1′- 9″	18	¾″x2 3/16″
325000	9′-0″	1′- 9″	28	¾″x2 3/16″	8′-0″	1′- 7″	22	¾″x2 3/16″	7′-6″	1′-11″	24	¾″x2 3/16″
350000	9′-6″	1′-11″	18	1½″x2¼″	8′-6″	2′- 2″	24	¾″x2 3/16″	7′-9″	1′-11″	24	¾″x2 3/16″
375000	9′-9″	1′-11″	18	1½″x2¼″	8′-9″	2′- 2″	26	¾″x2 3/16″	8′-0″	2′- 0″	24	¾″x2 3/16″
400000	10′-0″	2′- 0″	18	1½″x2¼″	9′-0″	2′- 3″	28	¾″x2 3/16″	8′-3″	2′- 1″	26	¾″x2 3/16″
425000	10′-3″	2′- 7″	20	1½″x2¼″	9′-3″	2′- 4″	28	¾″x2 3/16″	8′-6″	2′- 2″	30	¾″x2 3/16″
450000	10′-9″	2′- 8″	22	1½″x2¼″	9′-6″	2′- 5″	16	1½″x2¼″	8′-9″	2′- 2″	32	¾″x2 3/16″
475000	11′ 0″	2′- 9″	22	1½″x2¼″	9′-9″	2′- 5″	18	1½″x2¼″	9′-0″	2′- 3″	18	1½″x2¼″
500000	11′-3″	2′-10″	24	1½″x2¼″	10′-0″	2′- 6″	20	1½″x2¼″	9′-3″	2′- 4″	20	1½″x2¼″
525000	11′-6″	2′-11″	24	1½″x2¼″	10′-3″	2′- 7″	22	1½″x2¼″	9′-6″	2′- 5″	22	1½″x2¼″
550000	11′-9″	2′-11″	26	1½″x2¼″	10′-6″	2′- 7″	22	1½″x2¼″	9′-6″	2′- 5″	22	1½″x2¼″
575000	12′-0″	3′- 0″	26	1½″x2¼″	10′-9″	2′- 8″	24	1½″x2¼″	9′-9″	2′- 5″	24	1½″x2¼″
600000	12′-3″	3′- 1″	28	1½″x2¼″	11′-0″	2′- 9″	26	1½″x2¼″	10′-0″	2′- 6″	24	1½″x2¼″

Table of Reinforced Concrete Footings

Soil Value per Sq. Ft.	7000 LBS.				8000 LBS.				9000 LBS.				10,000 LBS.			
Load in Lbs. on Footing	Size of Footing		Kahn Trussed Bars		Size of Footing		Kahn Trussed Bars		Size of Footing		Kahn Trussed Bars		Size of Footing		Kahn Trussed Bars	
	Sq.	Depth	No.	Size	Sq.	Depth	No.	Size	Sq.	Depth	No.	Size	Sq.	Depth	No.	Size
100000	4'-0"	0'-10"	12	½"x1½"												
125000	4'-3"	0'-10"	14	½"x1½"	4'-0"	0'-10"	16	½"x1½"								
150000	4'-9"	0'-11"	18	½"x1½"	4'-6"	0'-10"	18	½"x1½"	4'-3"	0'-10"	16	½"x1½"	4'-0"	0'-10"	12	½"x1½"
175000	5'-0"	1'-0"	18	½"x1½"	4'-9"	0'-11"	18	½"x1½"	4'-6"	0'-10"	18	½"x1½"	4'-3"	0'-10"	14	½"x1½"
200000	5'-6"	1'-4"	12	¾"x2 3/16"	5'-0"	1'-0"	18	½"x1½"	4'-9"	0'-11"	18	½"x1½"	4'-6"	0'-10"	16	½"x1½"
225000	5'-9"	1'-5"	14	¾"x2 3/16"	5'-6"	1'-4"	14	¾"x2 3/16"	5'-0"	1'-0"	20	½"x1½"	4'-9"	1'-2"	18	½"x1½"
250000	6'-0"	1'-6"	16	¾"x2 3/16"	5'-9"	1'-5"	16	¾"x2 3/16"	5'-3"	1'-4"	12	¾"x2 3/16"	5'-0"	1'-3"	12	¾"x2 3/16"
275000	6'-3"	1'-7"	16	¾"x2 3/16"	6'-0"	1'-6"	18	¾"x2 3/16"	5'-6"	1'-4"	14	¾"x2 3/16"	5'-3"	1'-4"	14	¾"x2 3/16"
300000	6'-6"	1'-8"	18	¾"x2 3/16"	6'-3"	1'-7"	18	¾"x2 3/16"	5'-9"	1'-5"	14	¾"x2 3/16"	5'-6"	1'-4"	14	¾"x2 3/16"
325000	6'-9"	1'-8"	20	¾"x2 3/16"	6'-6"	1'-8"	20	¾"x2 3/16"	6'-0"	1'-6"	16	¾"x2 3/16"	5'-9"	1'-5"	16	¾"x2 3/16"
350000	7'-0"	1'-9"	20	¾"x2 3/16"	6'-9"	1'-8"	20	¾"x2 3/16"	6'-3"	1'-7"	18	¾"x2 3/16"	6'-0"	1'-6"	16	¾"x2 3/16"
375000	7'-3"	1'-10"	20	¾"x2 3/16"	7'-0"	1'-9"	20	¾"x2 3/16"	6'-6"	1'-8"	18	¾"x2 3/16"	6'-3"	1'-7"	16	¾"x2 3/16"
400000	7'-6"	1'-11"	22	¾"x2 3/16"	7'-0"	1'-9"	20	¾"x2 3/16"	6'-9"	1'-8"	20	¾"x2 3/16"	6'-3"	1'-7"	16	¾"x2 3/16"
425000	7'-9"	1'-11"	22	¾"x2 3/16"	7'-3"	1'-10"	20	¾"x2 3/16"	7'-0"	1'-9"	20	¾"x2 3/16"	6'-6"	1'-8"	18	¾"x2 3/16"
450000	8'-0"	2'-0"	24	¾"x2 3/16"	7'-6"	1'-11"	22	¾"x2 3/16"	7'-0"	1'-9"	20	¾"x2 3/16"	6'-9"	1'-8"	20	¾"x2 3/16"
475000	8'-3"	2'-1"	26	¾"x2 3/16"	7'-9"	1'-11"	24	¾"x2 3/16"	7'-3"	1'-10"	22	¾"x2 3/16"	7'-0"	1'-9"	20	¾"x2 3/16"
500000	8'-6"	2'-2"	30	¾"x2 3/16"	8'-0"	2'-0"	26	¾"x2 3/16"	7'-6"	1'-11"	24	¾"x2 3/16"	7'-0"	1'-9"	20	¾"x2 3/16"
525000	8'-9"	2'-2"	32	¾"x2 3/16"	8'-3"	2'-1"	28	¾"x2 3/16"	7'-9"	1'-11"	26	¾"2x 3/16"	7'-3"	1'-10"	22	¾"x2 3/16"
550000	9'-0"	2'-3"	20	1½"x2¼"	8'-3"	2'-1"	28	¾"x2 3/16"	7'-9"	1'-11"	26	¾"x2 3/16"	7'-6"	1'-11"	24	¾"x2 3/16"
575000	9'-0"	2'-3"	20	1½"x2¼"	8'-6"	2'-2"	30	¾"x2 3/16"	8'-0"	2'-0"	28	¾"x2 3/16"	7'-6"	1'-11"	24	¾"x2 3/16"
600000	9'-3"	2'-4"	22	1½"x2¼"	8'-9"	2'-2"	32	¾"x2 3/16"	8'-3"	2'-1"	30	¾"x2 3/16"	7'-9"	1'-11"	26	¾"x2 3/16"

Quantities of Material for One Cubic Yard of Rammed
Plain and Reinforced,"

Proportions by Parts			Proportions by Volume				PER CEN		
							50% Broken Stone Screened to Uniform Size		
Cement	Sand	Stone	Packed Cement	Loose Sand	Loose Stone	Volume of Mortar in Terms of Percentage of Volume of Stone	Cement	Sand	Stone
			Bbl.	Cu. Ft.	Cu. Ft.	Per Cent.	Bbl.	Cu. Yd.	Cu. Yd.
1	1	1.5	1	3.8	5.7	99	3.19	0.45	0.67
1	1	2	1	3.8	7.6	75	2.85	0.40	0.80
1	1	2.5	1	3.8	9.5	61	2.57	0.36	0.90
1	1	3	1	3.8	11.4	51	2.34	0.33	0.99
1	1.5	2	1	5.7	7.6	93	2.49	0.53	0.70
1	1.5	2.5	1	5.7	9.5	76	2.27	0.48	0.80
1	1.5	3	1	5.7	11.4	64	2.09	0.44	0.88
1	1.5	3.5	1	5.7	13.3	55	1.94	0.41	0.96
1	1.5	4	1	5.7	15.2	49	1.80	0.38	1.01
1	1.5	4.5	1	5.7	17.1	44	1.69	0.36	1.07
1	1.5	5	1	5.7	19.0	40	1.59	0.34	1.12
1	2	3	1	7.6	11.4	75	1.89	0.53	0.80
1	2	3.5	1	7.6	13.3	65	1.76	0.49	0.87
1	2	4	1	7.6	15.2	57	1.65	0.46	0.93
1	2	4.5	1	7.6	17.1	51	1.55	0.44	0.98
1	2	5	1	7.6	19.0	47	1.47	0.41	1.03
1	2	5.5	1	7.6	20.9	43	1.39	0.39	1.08
1	2	6	1	7.6	22.8	40	1.32	0.37	1.11
1	2.5	3	1	9.5	11.4	87	1.72	0.61	0.73
1	2.5	3.5	1	9.5	13.3	75	1.62	0.57	0.80
1	2.5	4	1	9.5	15.2	66	1.52	0.54	0.86
1	2.5	4.5	1	9.5	17.1	60	1.44	0.51	0.91
1	2.5	5	1	9.5	19.0	54	1.37	0.48	0.96
1	2.5	5.5	1	9.5	20.9	49	1.30	0.46	1.01
1	2.5	6	1	9.5	22.8	46	1.24	0.44	1.05
1	2.5	6.5	1	9.5	24.7	42	1.18	0.42	1.08
1	2.5	7	1	9.5	26.6	40	1.13	0.40	1.11
1	3	4	1	11.4	15.2	76	1.42	0.60	0.80
1	3	4.5	1	11.4	17.1	68	1.34	0.57	0.85
1	3	5	1	11.4	19.0	61	1.28	0.54	0.90
1	3	5.5	1	11.4	20.9	56	1.22	0.52	0.94
1	3	6	1	11.4	22.8	52	11.6	0.49	0.98
1	3	6.5	1	11.4	24.7	48	1.12	0.47	1.02

oncrete Based on a Bbl. of 3.8 Cu. Ft. from "Concrete, aylor & Thompson.

GE OF VOIDS IN BROKEN STONE OR GRAVEL											
45% Average Conditions			40% Gravel			30% Scientifically Graded Mixtures			20%		
Cement	Sand	Stone	Cement	Sand	Stone	Cement	Sand	Stone	Cement	Sand	Stone
Bbl.	Cu. Yd.	Cu. Yd.	Bbl.	Cu. Yd.	Cu. Yd.	Bbl.	Cu. Yd.	Cu. Yd.	Bbl.	Cu. Yd.	Cu. Yd.
3.08	0.43	0.65	2.97	0.42	0.63	2.78	0.39	0.59	2.62	0.37	0.55
2.73	0.38	0.77	2.62	0.37	0.74	2.43	0.34	0.68	2.26	0.32	0.64
2.45	0.34	0.86	2.34	0.33	0.82	2.15	0.30	0.76	1.99	0.28	0.70
2.22	0.31	0.94	2.12	0.30	0.90	1.93	0.27	0.82	1.77	0.25	0.75
2.40	0.51	0.68	2.31	0.49	0.65	2.16	0.46	0.61	2.03	0.43	0.57
2.18	0.46	0.77	2.09	0.44	0.74	1.94	0.41	0.68	1.80	0.38	0.63
2.00	0.42	0.84	1.91	0.40	0.81	1.76	0.37	0.74	1.63	0.34	0.64
1.84	0.39	0.91	1.76	0.37	0.87	1.61	0.34	0.79	1.48	0.31	0.73
1.71	0.36	0.96	1.63	0.34	0.92	1.48	0.31	0.83	1.36	0.29	0.77
1.60	0.34	1.01	1.51	0.32	0.96	1.37	0.29	0.87	1.25	0.26	0.79
1.50	0.32	1.06	1.42	0.30	1.00	1.28	0.27	0.90	1.17	0.25	0.82
1.81	0.51	0.76	1.74	0.49	0.74	1.61	0.45	0.68	1.50	0.42	0.63
1.68	0.47	0.83	1.61	0.45	0.79	1.48	0.42	0.73	1.38	0.39	0.68
1.57	0.44	0.88	1.50	0.42	0.84	1.38	0.39	0.78	1.27	0.36	0.72
1.48	0.42	0.94	1.41	0.40	0.89	1.28	0.36	0.81	1.18	0.33	0.75
1.39	0.39	0.98	1.32	0.37	0.93	1.20	0.34	0.84	1.10	0.31	0.77
1.31	0.37	1.01	1.25	0.35	0.97	1.13	0.32	0.87	1.03	0.29	0.80
1.25	0.35	1.06	1.18	0.33	1.00	1.06	0.30	0.89	0.97	0.27	0.82
1.66	0.58	0.70	1.60	0.56	0.68	1.49	0.52	0.63	1.40	0.49	0.59
1.55	0.55	0.76	1.49	0.52	0.73	1.38	0.49	0.68	1.29	0.45	0.64
1.46	0.51	0.82	1.40	0.49	0.79	1.29	0.45	0.73	1.19	0.42	0.67
1.37	0.48	0.87	1.31	0.46	0.83	1.20	0.42	0.76	1.11	0.39	0.70
1.30	0.46	0.92	1.24	0.44	0.87	1.13	0.40	0.80	1.04	0.37	0.73
1.23	0.44	0.95	1.17	0.41	0.91	1.07	0.38	0.83	0.98	0.34	0.76
1.17	0.41	0.99	1.11	0.39	0.94	1.01	0.36	0.85	0.92	0.32	0.78
1.12	0.39	1.02	1.06	0.37	0.97	0.96	0.34	0.88	0.88	0.31	0.80
1.07	0.37	1.05	1.01	0.36	0.99	0.91	0.32	0.90	0.83	0.29	0.82
1.36	0.36	0.77	1.30	0.55	0.73	1.21	0.51	0.68	1.12	0.47	0.63
1.28	0.55	0.81	1.23	0.52	0.78	1.13	0.48	0.72	1.05	0.44	0.66
1.22	0.52	0.86	1.17	0.49	0.82	1.07	0.45	0.75	0.99	0.42	0.70
1.16	0.49	0.90	1.11	0.47	0.86	1.10	0.43	0.78	0.93	0.39	0.72
1.11	0.47	0.94	1.05	0.44	0.89	0.96	0.41	0.81	0.88	0.37	0.74
1.06	0.45	0.97	1.01	0.43	0.92	0.92	0.39	0.84	0.84	0.35	0.77

Materials for One Cubic Yard Compact Plastic Mortar Based on Barrel of 3.8 Cu. Ft.

From "Concrete, Plain and Reinforced"
By Taylor & Thompson

Relative Proportions by Parts		Relative Proportions by Volume		Packed Cement Barrel	Loose Sand Cubic Yard
Cement	Sand	Cement Barrel	Sand Cubic Yard		
1	0	1		8.31	
1	½	1	1.9	6.73	0.47
1	1	1	3.8	5.01	0.71
1	1½	1	5.7	4.00	0.84
1	2	1	7.6	3.32	0.93
1	2½	1	9.5	2.84	1.00
1	3	1	11.4	2.48	1.05
1	3½	1	13.3	2.20	1.08
1	4	1	15.2	1.98	1.11
1	4½	1	17.1	1.80	1.14
1	5	1	19.0	1.65	1.16
1	5½	1	20.9	1.52	1.18
1	6	1	22.8	1.41	1.19
1	6½	1	24.7	1.32	1.21
1	7	1	26.6	1.23	1.21
1	7½	1	28.5	1.16	1.22
1	8	1	30.4	1.10	1.24

NOTE:—Variation in the fineness of the cement and the sand, and in the consistency of the mortar, may affect the values by 10% in either direction.

Cement—as packed by manufacturer.

Sand—loose.

Estimating Table

Cubic Feet of Concrete Per Lineal Foot in Rectangular Beams and Columns

Size in Ins.	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
8	.22	.33	.44														
10	.28	.42	.56	.70													
12	.33	.50	.67	.83	1.00												
14	.39	.58	.78	.97	1.17	1.36											
16	.44	.67	.89	1.11	1.33	1.56	1.78										
18	.50	.75	1.00	1.25	1.50	1.75	2.00	2.25									
20	.56	.83	1.11	1.39	1.67	1.95	2.22	2.50	2.78								
22	.61	.92	1.22	1.53	1.83	2.14	2.44	2.75	3.05	3.36							
24	.67	1.00	1.33	1.67	2.00	2.33	2.67	3.00	3.33	3.67	4.00						
26	.72	1.08	1.44	1.81	2.17	2.53	2.89	3.25	3.61	3.97	4.33	4.70					
28	.78	1.17	1.56	1.94	2.33	2.72	3.11	3.50	3.89	4.28	4.67	5.06	5.45				
30	.83	1.25	1.67	2.08	2.50	2.92	3.33	3.75	4.17	4.58	5.00	5.42	5.83	6.25			
32	.89	1.33	1.78	2.22	2.67	3.11	3.56	4.00	4.45	4.89	5.33	5.78	6.22	6.67	7.11		
34	.94	1.42	1.89	2.36	2.83	3.30	3.78	4.25	4.73	5.20	5.67	6.14	6.61	7.08	7.56		
36	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00	8.50	9.00
38	1.06	1.58	2.11	2.64	3.17	3.70	4.22	4.75	5.28	5.81	6.33	6.86	7.39	7.91	8.44	8.97	9.50
40	1.11	1.67	2.22	2.78	3.33	3.89	4.44	5.00	5.56	6.12	6.67	7.22	7.78	8.34	8.89	9.44	10.00
42	1.17	1.75	2.33	2.92	3.50	4.09	4.67	5.25	5.83	6.42	7.00	7.59	8.17	8.75	9.33	9.91	10.50
44	1.22	1.83	2.44	3.06	3.67	4.28	4.89	5.50	6.11	6.72	7.33	7.95	8.56	9.17	9.98	10.39	11.00
46	1.28	1.92	2.56	3.20	3.83	4.47	5.11	5.75	6.39	7.03	7.67	8.31	8.95	9.58	10.22	10.85	11.50
48	1.33	2.00	2.67	3.33	4.00	4.67	5.33	6.00	6.67	7.33	8.00	8.67	9.33	10.00	10.67	11.33	12.00
50	1.39	2.08	2.78	3.47	4.17	4.86	5.56	6.25	6.94	7.64	8.33	9.03	9.72	10.42	11.11	11.80	12.50
52	1.44	2.17	2.89	3.61	4.33	5.06	5.78	6.50	7.22	7.95	8.67	9.39	10.11	10.83	11.56	12.28	13.00
54	1.50	2.25	3.00	3.75	4.50	5.25	6.00	6.75	7.50	8.25	9.00	9.75	10.50	11.25	12.00	12.75	13.50
56	1.56	2.33	3.11	3.89	4.67	5.44	6.22	7.00	7.78	8.56	9.33	10.11	10.89	11.67	12.44	13.22	14.00
58	1.61	2.42	3.22	4.02	4.83	5.64	6.44	7.25	8.05	8.86	9.67	10.47	11.28	13.08	12.89	13.69	14.50
60	1.67	2.50	3.33	4.17	5.00	5.83	6.67	7.50	8.33	9.17	10.00	10.83	11.67	12.50	13.33	14.17	15.00
Round Columns			.35	.55	.79	1.07	1.40	1.77	2.18	2.64	3.14	3.69	4.28	4.91	5.59	6.31	7.07

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